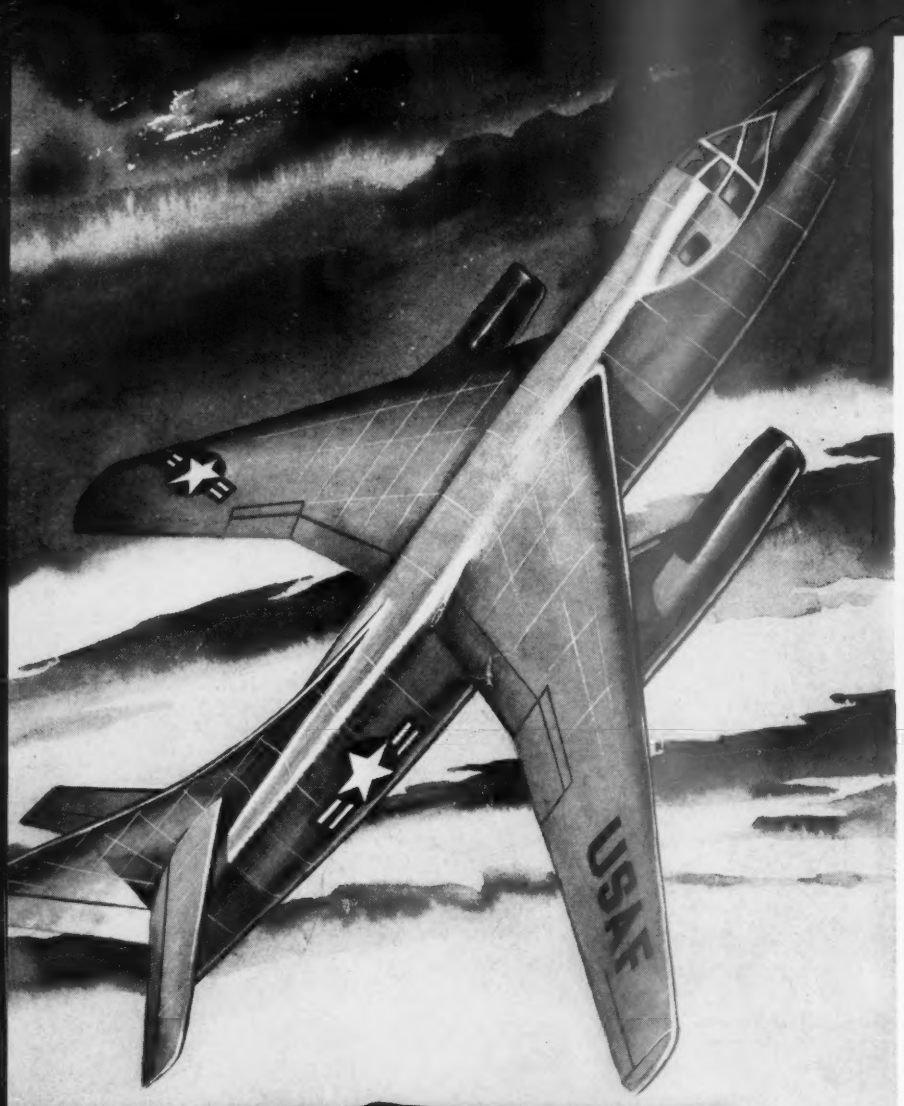
629 TR-1

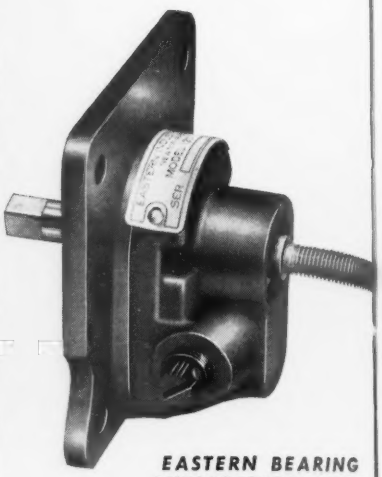
Aeronautical Engineering REVIEW

THE JOHN CRERAR LIBRARY
MAR 12 1957

March, 1957



with smaller, lighter parts

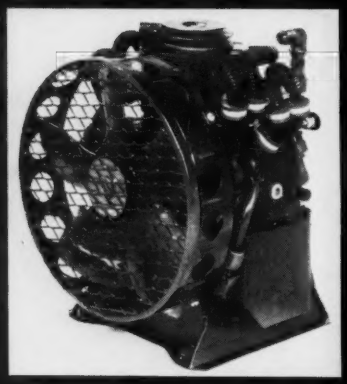


EASTERN BEARING LUBRICATION PUMP
Small enough to hide in one hand! Only 10 ozs.

The Walter Kidde 4-D Compress gives 11¼ pounds of pneumatic power in a space 10″ square. Th light, small unit is a masterpiece of engineering requiring small components. The Eastern Lubric tion Pump has what it takes for this task. A bantam in size and weight . . . a heavyweight in performance.

Eastern has solved many such problems in hydraulics . . . and i pressurization and electronic tub cooling units too. Inquiries are welcome regarding custom-made equipment to meet your require- ments to government specification

Write for Aircraft Catalog



Power for Pneumatic Systems

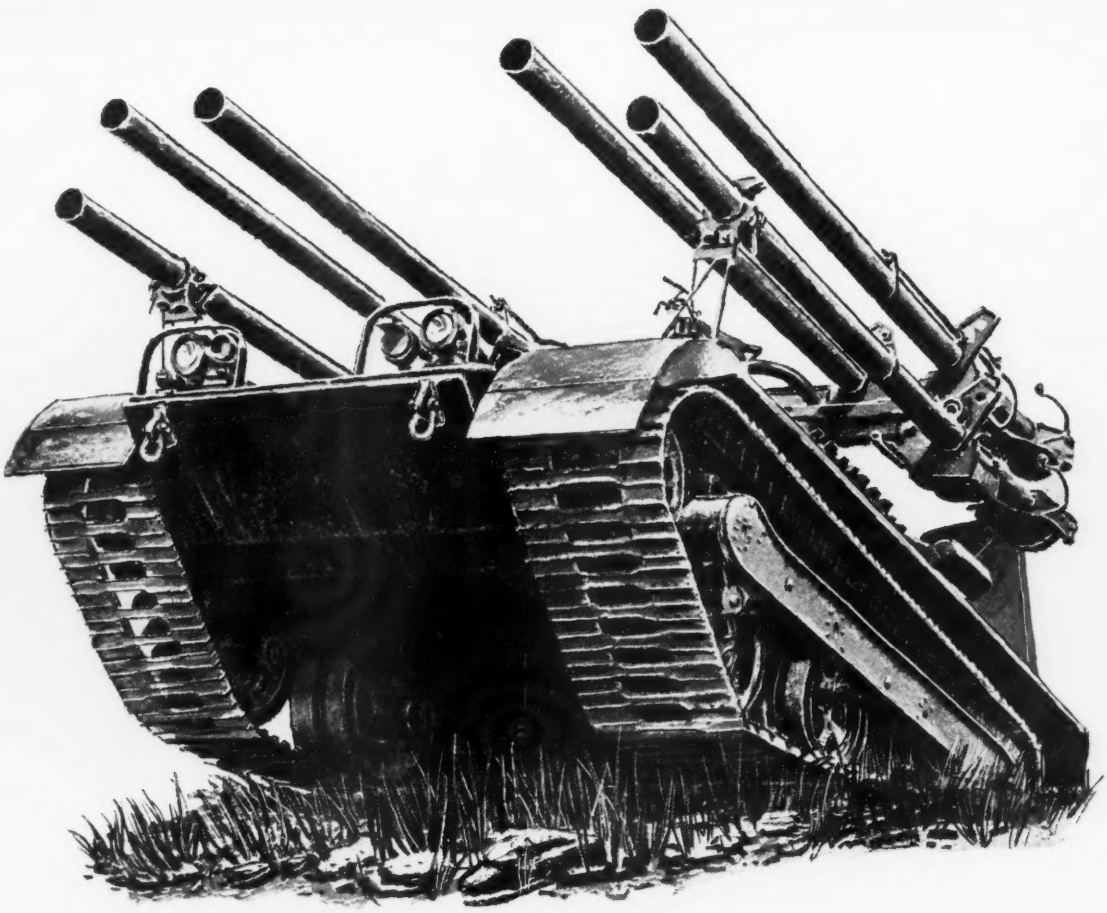
WALTER KIDDE 4-D COMPRESSOR
Smaller than a basketball . . . yet packed with power.

Mike Lucnetti

Eastern

EASTERN AVIATION PRODUCTS

INDUSTRIES, IN
100 SKIFF STREET
HAMDEN 14, CONN.



"ONTOS"! land-bound fighter with airplane-type fuel cells

Low, lean and lethal — this is the "Ontos," new land combat vehicle of the U. S. Marine Corps, with more firepower than any other in history.

Highly maneuverable, it is a hit-run weapon which relies upon its low silhouette to get in, strike and get out fast.

This low silhouette is made possible, in part, through an airplane-type fuel cell — built by Goodyear Aviation Products—which is "tunneled" so that the vehicle's drive shaft runs right through it.

By utilizing bladder cells and aircraft-type fittings to replace conventional rigid metal-tank construction — fuel-tank bounce, vibration and corrosion problems are eliminated.

Produced by Allis-Chalmers at its La Porte, Indiana, Works, the Ontos gets its name from the Greek for "the Thing." And what a thing it is: a multi-purpose combat vehicle that does the work of twelve — a feat made possible partly by aeronautical pioneering.

Goodyear Aviation Products Division is a leader in the field of fuel cells, for aircraft, boats, guided missiles and vehicles. For full information, write: Goodyear, Aviation Products Division, Dept. C-1711, Akron 16, Ohio, and Los Angeles 54, California.

GOODYEAR
AVIATION
PRODUCTS

PUBLICATION STAFF

EDITOR: Welman A. Shrader
MANAGING EDITOR: Rita J. Turino
ASSISTANT EDITOR: Allan Bernhardt
REVIEWS EDITOR: Irene W. Bogolubsky
BOOK REVIEWS EDITOR: John J. Glennon
EDITORIAL ASSISTANTS: Helen S. Goldman
Justine C. Pruyn

TECHNICAL ADVISERS
W. R. Sears • Robert R. Dexter • S. Paul Johnston

ADVERTISING MANAGER: Joseph P. Ryan
BUSINESS MANAGER: Hugh C. Judge
ADVERTISING PRODUCTION MGR.: R. N. Lipner

EDITORIAL ADVISORY COMMITTEES

Aircraft Design, Structures, & Materials

A. Francis Arcier
Wellwood E. Beall
William B. Bergen
Fred N. Dickerman
Robert L. Hall
Edward H. Heinemann
Harold D. Hoekstra
C. L. Johnson
Alexander Kartveli
Kendall Perkins
Richard L. Schleicher
Edgar Schmued
Igor I. Sikorsky
Ernest G. Stout
Kirby F. Thornton
Walter Tydon

Flight Propulsion

George W. Brady
Dimitrius Gerdan
Leonard S. Hobbs
R. P. Kroon
Everard M. Lester
W. G. Lundquist
Abe Silverstein
Philip B. Taylor
E. S. Thompson
Raymond W. Young

Instruments

Preston R. Bassett
Victor E. Carbonara
Charles H. Colvin
Frank R. Cook
Richard M. Mock
Walter H. Skidmore
R. C. Sylvander

Air Transport & Operations

Charles Froesch
J. A. Herlihy
John C. Leslie
William Littlewood
R. W. Rummel
R. Dixon Speas

Electronics

K. C. Black
Bruce G. Eaton, Jr.
Richard B. Hubbard
David S. Little
Frank Mansur
John Margosian
P. C. Sandretto

Specialties

Robert J. Benford, M.D.
Melvin N. Gough
Jerome Lederer

SUBSCRIPTION RATES

Aeronautical Engineering Review: United States and possessions, 1 year, $3.00; single copies, $0.50. Foreign countries including Canada (American Currency Rates), 1 year, $3.50; single copies, $0.50.

Entered as second-class matter at the Post Office, Easton, Pa., April 29, 1942. Acceptance for mailing at a Special Rate of Postage as provided for in the Act of August 24, 1912.

Publication Office: 20th & Northampton Streets, Easton, Pa.

Editorial Office: 2 East 64th Street, New York 21, N.Y. Notices of change of address should be sent to the Institute at least 30 days prior to actual change of address.

Statements and opinions expressed in the Aeronautical Engineering Review are to be understood as individual expressions and not those of the Institute.

© *Copyright, 1957, by the Institute of the Aeronautical Sciences, Inc.*

Aeronautical Engineering REVIEW

Vol. 16—No. 3 March, 1957

CONTENTS

Progress in Low Drag Boundary-Layer Control.....*Edgar Schmued* 34

Elevated Temperature Requirements for a New Air-Borne Flight Analyzer.....*Christian J. Van Der Maas* 37

Air Safety Problems.....*Welman A. Shrader and R. C. McGuire* 42

Understanding and Interpreting Pilot Opinion.....*George E. Cooper* 47

Problems in Estimating Structure Weights.....*Mervyn G. Heal* 52

The Flight Surgeon and Aircraft Accidents.....*Capt. Carl E. Wilbur (MC), USN* 57

IAS News Notes..... 17
IAS News..... 19
Officers, 1957..... 20
Council, 1957..... 21
Fellowships, 1956..... 27
Awards, 1956..... 28
Editorial..... 32
Aeronautical Reviews..... 83
International Aeronautical Abstracts..... 101
Sherman M. Fairchild Publication Fund Papers. 164
Books..... 167
Personnel Opportunities..... 175
Index to Advertisers..... 179
New Products and Product Literature..... 181

Cover—First photo of the Air Force B-58 Hustler bomber manufactured by Convair, A Division of General Dynamics Corporation, shows its "Daddy Long-Legs" landing gear and 18 wheels reaching for the runway after test flight. The delta-wing bomber has been undergoing flight tests since November 11 at Convair's Fort Worth plant. Four General Electric J-79 jet engines with afterburners supply power. Ninety-five feet long with a wing span of 55 ft., it carries a crew of three.

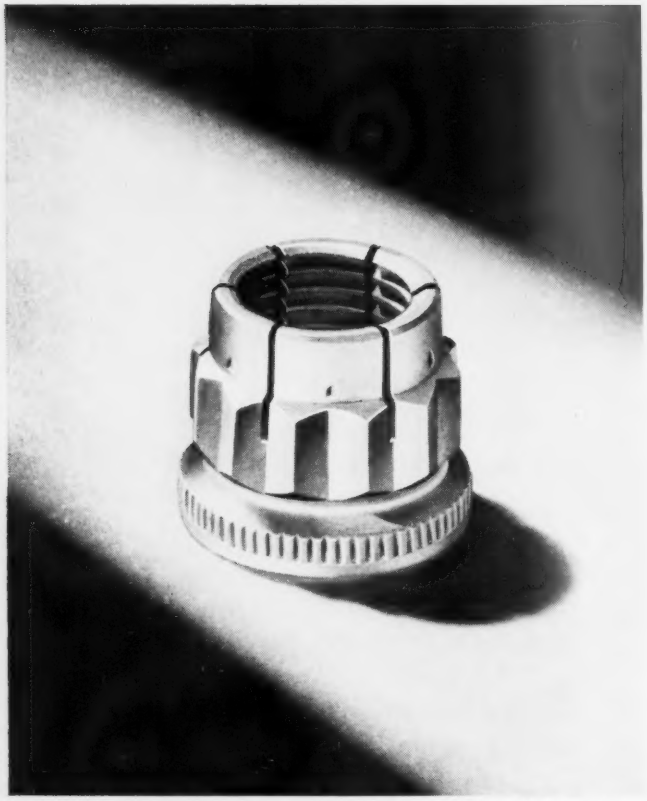
Published Monthly by the

Institute of the Aeronautical Sciences, Inc.

2 East 64th Street, New York 21, N.Y.

Western Office: 7660 Beverly Blvd., Los Angeles 36, Calif.

NEW—SPS 119 FW aircraft locknut for applications up to 1200°F



NEW SPS 119 FW self-locking nut is made of corrosion and heat-resistant alloys, silver plated. It incorporates the reliable SPS FLEXLOC self-locking feature, which locks the nut securely in place without auxiliary locking devices. These nuts are precision manufactured to Class 3B fit.

Critical components operating under high temperatures in jet engines—in manifolds, afterburners and similar hot spots—cannot be kept fastened with ordinary locknuts. In high temperatures, such nuts soften and fail from loss of tensile strength. They also seize after cooling. Often removal of the nuts can then be so difficult that the parts they hold together are damaged in disassembly.

SPS 119 FW high temperature locknuts were designed to end such problems. Made of corrosion and heat-resistant alloys, and silver plated to exact specification, they retain their high tensile strength in temperatures up to 1200°F. And they withstand hundreds of cycles of heating and cooling without galling or seizing on mating threads.

For complete information about SPS 119 FW 1200°F locknuts or the complete line of standard SPS threaded aircraft fasteners, or for assistance with your special aircraft threaded fastener problem, write us today. Aircraft Products Division, STANDARD PRESSED STEEL Co., Jenkintown 58, Pa.

AIRCRAFT PRODUCTS DIVISION

STANDARD PRESSED STEEL CO.

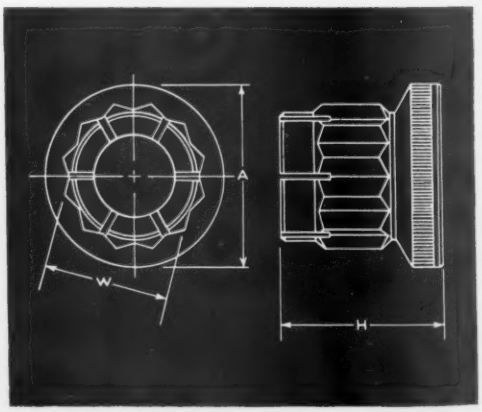
SPS

JENKINTOWN ■ PENNSYLVANIA

SPECIFICATIONS

Size	A ±.010	H ±.005	W max	W min
10-32	.375	.350	.313	.304
¼-28	.438	.406	.376	.367
5/16-24	.531	.468	.439	.430
⅜-24	.593	.500	.502	.492
7/16-20	.687	.570	.564	.553
½-20	.781	.604	.627	.616

Standard sizes range from #10 to ½ in. diameter. Other SPS high temperature aircraft locknuts are available in larger sizes. Write for details.



GOT THAT "PIGEON-HOLED" FEELING?

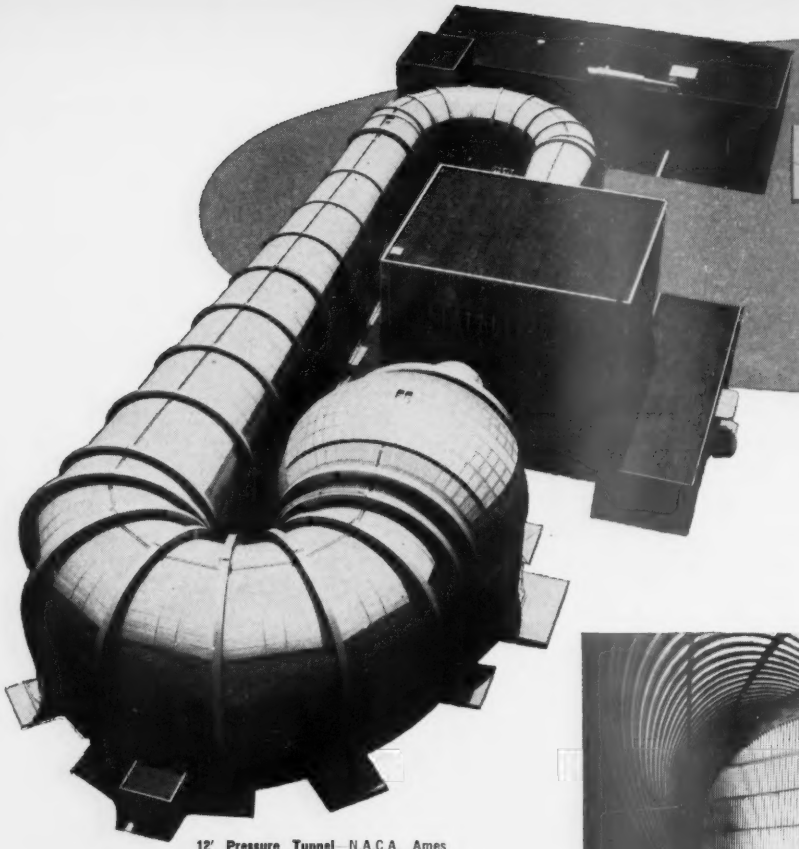
If you're an engineer, scientist or mathematician with that "pigeon-holed" feeling... if you'd like to work with a *young man's* company... if you've had an eye on Southern California's kind of relaxed, outdoor living – then we urge you to write us today! We'll fill you in on the exciting *diversity* of engineering and scientific projects at Convair. How you can apply for a *top-paying* assignment on such advanced aircraft as the 880 – world's fastest commercial jet airliner; the F-102A – first supersonic interceptor; or long-range research on nuclear aircraft. Write today – it could be the best move of your life!

Send letter or resume to: Mr. H. T. Brooks,
Engineering Personnel, Dept. 63-A

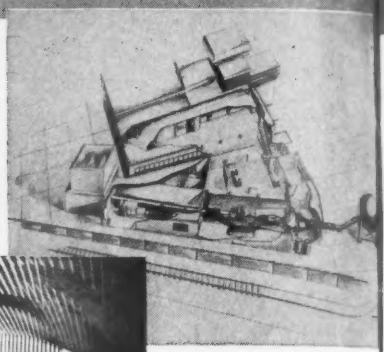
CONVAIR
SAN DIEGO
3302 Pacific Highway • San Diego, California

CONVAIR IS A DIVISION OF GENERAL DYNAMICS CORPORATION

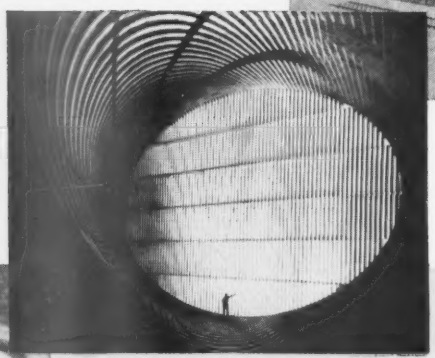
PITTSBURGH · DE
Wind Tu

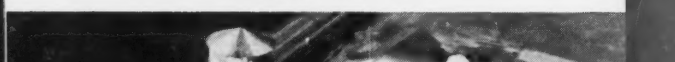


12' Pressure Tunnel—N.A.C.A. Ames Laboratory, Moffett Field, Calif.



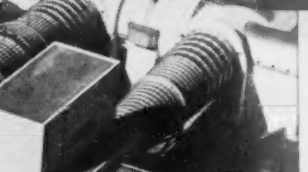
4' x 4' Supersonic Blowdown Tunnel—Under construction for Boeing Airplane Company, Seattle, Wash.





Remodeled 16' Tunnel—N.A.C.A. Langley Aeronautical Laboratory, Langley Field, Va.

16' x 16' Transonic Tunnel—Arnold Engineering Development Center, Tullahoma, Tenn.



40' x 80' Tunnel—N.A.C.A. Ames Laboratory, Moffett Field, Calif.

THE ROLL CALL

Tunnels by PDM

U. S. AIR FORCE
16' x 16' Transonic Tunnel
Arnold Engineering Development Center
Tullahoma, Tennessee

U. S. AIR FORCE
16' x 16' Supersonic Tunnel
Arnold Engineering Development Center
Tullahoma, Tennessee

U. S. AIR FORCE
By-Pass Shell for Compressor, 16' x 16' Supersonic Tunnel
Arnold Engineering Development Center
Tullahoma, Tennessee

U. S. AIR FORCE
Intermittent Air Heater for Rom Jet Addition
Arnold Engineering Center
Tullahoma, Tennessee

U. S. AIR FORCE
Two Continuous Air Heaters
Wright-Patterson AF Base

U. S. AIR FORCE
3' Propeller Hub Altitude Test Facility
Wright-Patterson AF Base

U. S. AIR FORCE
Nozzle for Supersonic Tunnel
Wright-Patterson AF Base

U. S. AIR FORCE
Transonic Test Section for 10' Tunnel
Wright-Patterson AF Base

U. S. ARMY (Ordnance)
Two Supersonic Tunnels
Aberdeen Proving Ground, Md.

U. S. ARMY (Ordnance)
Sonic Wind Tunnel
Pickatinny Arsenal, N. J.

N.A.C.A.
Free Flight Apparatus
Langley Aeronautical Laboratory
Wallops Island, Va.

N.A.C.A.
40' x 80' Tunnel
Ames Laboratory
Moffett Field, Calif.

N.A.C.A.
12' Pressure Tunnel
Ames Laboratory
Moffett Field, Calif.

N.A.C.A.
1' x 3' Supersonic Tunnels
Ames Laboratory
Moffett Field, Calif.

N.A.C.A.
1' x 3' Atmospheric Tunnel
Ames Laboratory
Moffett Field, Calif.

N.A.C.A.
6' x 6' Supersonic Tunnel
Ames Laboratory
Moffett Field, Calif.

N.A.C.A.
Rebuilding 16' Tunnel
Ames Laboratory
Moffett Field, Calif.

N.A.C.A.
20' Low Pressure Low Temperature Tunnel
Lewis Flight Propulsion Lab.
Cleveland, Ohio

N.A.C.A.
7' x 10' Icing Research Tunnel
Lewis Flight Propulsion Lab.
Cleveland, Ohio

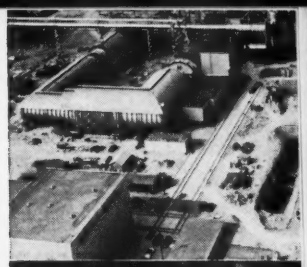
N.A.C.A.
8' Supersonic Tunnel
Lewis Flight Propulsion Lab.
Cleveland, Ohio

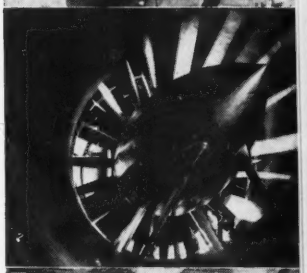
N.A.C.A.
Unitary Plan Tunnel
Lewis Flight Propulsion Lab.
Cleveland, Ohio

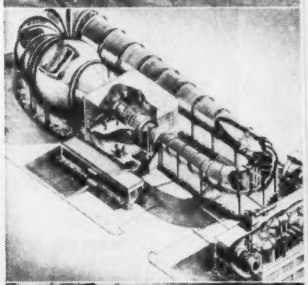
N.A.C.A.
19' Pressure Tunnel
Langley Aeronautical Lab.
Langley Field, Va.

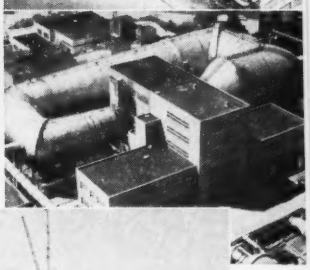
H-DES MOINES

d Tunnel Designers and Builders









for America's Aviation and Ordnance Research—

from SUBSONIC SPEEDS TO *Mach 5.0* and up

1956 marks the 20th year of this organization's leadership in the complex field of wind tunnel design, fabrication and construction. Our pioneering began with the first modern, closed circuit steel tunnel; we grew up with the problems of design-into-structure. Thus, Pittsburgh-Des Moines' experience in advanced aerodynamics, plus outstanding craftsmanship in steel, gives the aviation industry an organization capable of complete design, fabrication and construction of every type of wind tunnel for testing aircraft, engines and missiles—from the highest speeds of today to the hypersonic projects of tomorrow.

N.A.C.A.
Two Dimensional Pressure Tunnel
Langley Aeronautical Lab.
Langley Field, Va.

N.A.C.A.
16' Atmospheric Tunnel
Langley Aeronautical Lab.
Langley Field, Va.

N.A.C.A.
7' x 10' Low Speed Tunnel
Langley Aeronautical Lab.
Langley Field, Va.

N.A.C.A.
7' x 10' High Speed Tunnel
Langley Aeronautical Lab.
Langley Field, Va.

N.A.C.A.
Flutter Tunnel
Langley Aeronautical Lab.
Langley Field, Va.

N.A.C.A.
Rebuilding 16' Tunnel
Langley Aeronautical Lab.
Langley Field, Va.

N.A.C.A.
Modification of 7' x 10' H.S. Tunnel
Langley Aeronautical Lab.
Langley Field, Va.

N.A.C.A.
Air Storage System for Blow-Down Facility
Langley Aeronautical Lab.
Langley Field, Va.

N.A.C.A.
Conversion of 19' Pressure Tunnel
Langley Aeronautical Lab.
Langley Field, Va.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
10' Pressure Tunnel
Cambridge, Mass.

CORNELL LABORATORY
12' Pressure Tunnel
Buffalo, N. Y.

BOEING AIRPLANE CO.
4' x 4' Supersonic Blow-Down Tunnel
Seattle, Washington

McDONNELL AIRCRAFT COMPANY
7' x 10' Low Speed Tunnel
St. Louis, Mo.

NORTH AMERICAN AVIATION INC.
7' x 7' Trisonic Blow-Down Tunnel
El Segundo, Calif.

PRATT & WHITNEY AIRCRAFT
18' Engine Testing Tunnel
E. Hartford, Conn.

PRATT & WHITNEY AIRCRAFT
Blow-Down Facility
E. Hartford, Conn.

U. S. NAVY
2—8' x 10' Atmospheric Tunnels
David W. Taylor Model Basin
Carderock, Md.

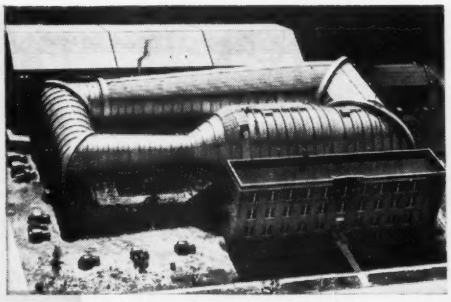
U. S. NAVY
Water Tunnel
Carderock, Md.

U. S. NAVY
Supersonic Tunnel and Burner Tunnels
Daingerfield, Texas

U. S. NAVY
Water Tunnel
Penna. State University
University Park, Pa.

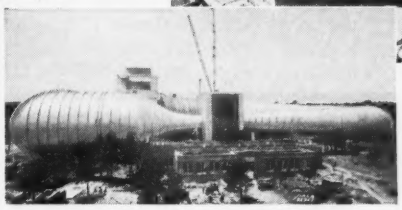
U. S. NAVY
32'5" Diam. Vacuum Sphere for Supersonic Tunnels
David W. Taylor Model Basin
Carderock, Md.

U. S. NAVY
Blow-Down Facility
Daingerfield, Texas



19' Pressure Tunnel—N.A.C.A. Langley Aeronautical Laboratory, Langley Field, Va.

6' x 6' Supersonic Tunnel—N.A.C.A. Ames Laboratory, Moffett Field, Calif.



16' Atmospheric Tunnel—N.A.C.A. Langley Aeronautical Laboratory, Langley Field, Va.

PITTSBURGH • DES MOINES STEEL CO.

Plants at Pittsburgh, Des Moines, Santa Clara, Fresno, and Cadiz, Spain

Sales Offices at:

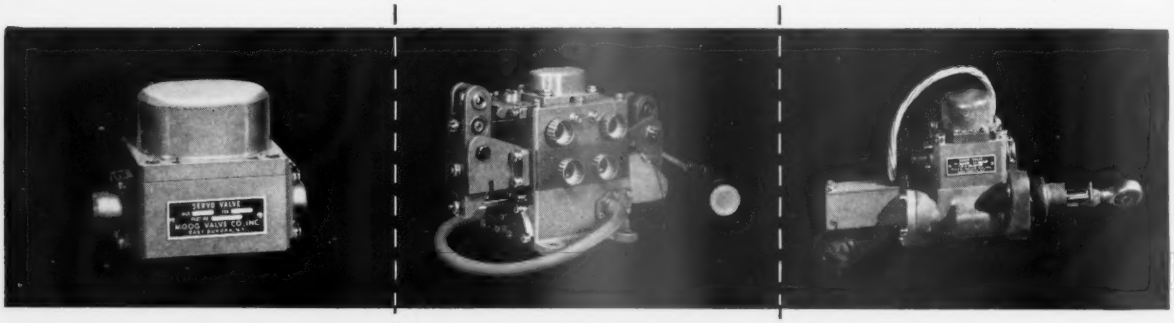
PITTSBURGH (25).....3472 Neville Island
NEWARK (2).....252 Industrial Office Bldg.
CHICAGO (3), 1276 First National Bank Bldg.
EL MONTE, CAL.....P. O. Box 2068
DES MOINES (8).....973 Tuttle Street
DALLAS (1).....1277 Praetorian Bldg.
SEATTLE.....580 Lane Street
SANTA CLARA, CALIF.....679 Alviso Road
MADRID, SPAIN.....Diego DeLeon, 60

PDM WIND TUNNELS

From MOOG . . . **Advanced Electro-Hydraulic Servo Components**

Moog is the industry's leading producer of electro-hydraulic servo valves. This leadership has been achieved by advanced valve design resulting in high performance, high quality, reliability and efficient manufacture. The same creative approach applied to industry's newer problems has resulted in the introduction of Moog Dual Input and Servo Actuator units.

These recent achievements in the creation of advanced custom designed electro-hydraulic servo components are evidence of Moog's continuing progress.



SERVO VALVE

• These proportional "dry motor" electro-hydraulic servo valves feature high dynamic response, sensitivity, linearity and reliability. Light-weight and compact, they are also available in custom designed versions for special or advanced applications.

DUAL INPUT SERVO VALVE

• This new component provides for positioning of aircraft control surfaces by summing mechanical and electrical inputs without external use of mechanical linkages. Use of an entirely new concept offers improved performance, system simplification and saving of space and weight.

SERVO ACTUATOR UNIT

• Custom designed integrated assemblies include actuating cylinder, electro-hydraulic servo valve and feedback sensing device. In a closed loop, actuator displacement is a function of input signal.

TO THE ENGINEER IN A "HURRY"

Axiomatically, to get somewhere in a hurry, you get aboard something that moves pretty fast.

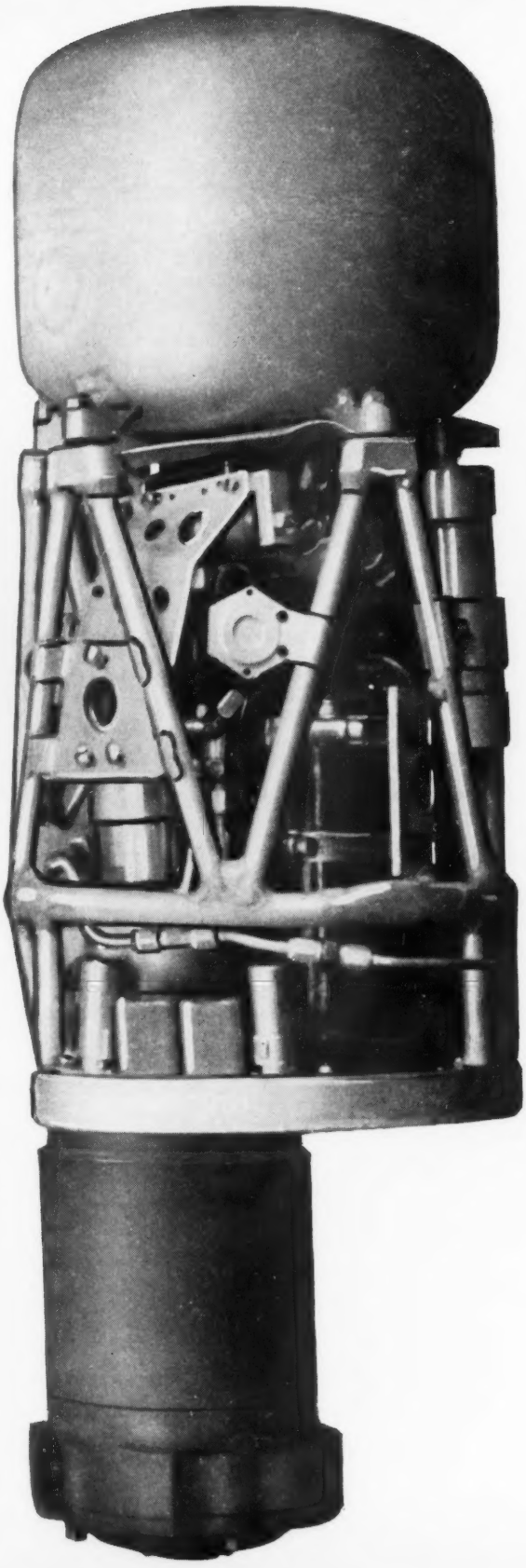
If your "somewhere" is a career in engineering, consider Moog. From three founders to five hundred employees within five years, we are today the industry's leading manufacturer of advanced electro-hydraulic servo components. Our engineers made this possible by continuous pioneering of the new and successful developments in the field. As our rapid expansion continues, we have many openings at all levels for qualified personnel.

Best time to get aboard is now.

MOOG

MOOG VALVE CO., INC. PRONER AIRPORT, EAST AURORA, NEW YORK

Research Laboratory, Paramus, New Jersey



Extra Muscle for Missiles

A DEPENDABLE SOURCE OF AUXILIARY POWER

Pioneers in the development of reliable, lightweight, self-contained monofuel auxiliary power systems for guided missiles and piloted high performance aircraft, Kidde now offers its combined engineering talents and precision manufacturing resources to firms interested in advanced applications of auxiliary power systems.

At present, Kidde has available turbine-driven units with horsepower of up to 200. These high speed units are designed to supply accurately regulated power at mean altitudes of 40,000 feet and up. However, they may easily be made environment-free, permitting airframe builders extremely wide latitude in systems design.

As a part of its power system development program, Kidde has gained wide experience with many monopropellants. These include ethylene oxide, hydrazine, hydrogen peroxide and propyl nitrate.

Whatever your present or future auxiliary power requirements, Kidde is ready to develop, test and manufacture equipment which will meet your exact specifications. For full information, write Kidde today.

Kidde

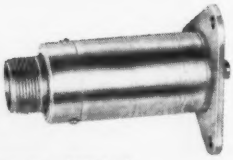
Walter Kidde & Company, Inc.
311 Main St., Belleville 9, N. J.
Walter Kidde & Company of Canada Ltd., Montreal

District Sales-Engineering Offices: Washington, D. C.; Dayton, Ohio; Dallas, Tex.; Seattle, Wash.; St. Louis, Mo.; Van Nuys, Calif.; Montreal, Canada; Belleville, N. J.

AIRCRAFT AND MISSILE CONTROLS

The components shown here are but a small cross-section of the entire range of products we design and manufacture. Many variations of these units have been created to suit specific requirements. A large part of our design effort is also devoted to the development of complete control systems having outstanding performance and reliability.

We invite you to discuss your present and future requirements on components or control systems with our engineering staff. Data sheets for current models are available. Please direct your inquiry to our plant at Danbury, Connecticut.

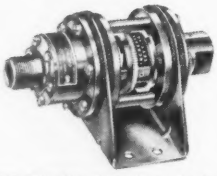


High Temperature (650° F.) PRESSURE SWITCH, Type 6576

CONSTRUCTION: All-welded stainless steel. Precision stacked-capsule sensing element. **TEMPERATURE RANGE:** —65° F. to 650° F. **ADJUSTMENT RANGE:** 20 to 75 psia. **RESET VALUE:** 2 psi. **CONTACTS:** 1 amp inductive snap action. **DIMENSIONS:** Diameter 1¼"; length 3½".

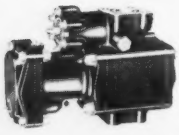
Differential PRESSURE SWITCH, Type 6580

DIFFERENTIAL ADJUSTMENT RANGE: 4" to 125" of water. **SYSTEM PRESSURES:** up to 60 psi. **RESET VALUE:** 1" to 3" of water (proportional to operating point). **EXTERNAL ADJUSTMENTS:** Separate adjustment of operating point and reset value. Alternate style provides two adjustable operating points with fixed reset values.



PRESSURE SWITCH (High Vibration), Type 6885

Integral vibration isolation. External adjustment doubly locked. Small physical size. Airframe, missile, rocket applications. **OPERATING RANGES:** 1 to 800 psi. **SYSTEM PRESSURES:** 5 to 3,000 psi. Available in single and dual assemblies, and in absolute pressure sensing model.

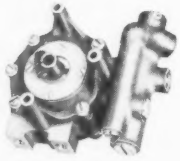


After Burner Fuel Control, Type 141RL37

Schedules afterburner fuel flow as a function of compressor discharge pressure absolute. Unique dual poppet design maintains constant pressure drop across the metering poppet; makes fuel flow a linear function of metering poppet lift. External adjustments permit slope and zero-shift alterations of flow versus compressor discharge pressure curve. **RATED FLOW:** 3,500 to 35,000 lbs/hr.

Dual Hydraulic Pressure Gauge, Type 6966

Dual hydraulic pressure indication within envelope normally occupied by single indicator. **DIAL SIZE:** 1⅞". Instant recognition of system condition—pointers horizontal denote full pressure. No translation. No reading of figures. Safety blow-out disc behind panel.



Rotary Torque Booster, Type 141F12

Controls fuel or hydraulic pressure to apply high level output force in response to low level input force. May be inserted in mechanical control linkage to reduce pilot effort. 8 to 1 torque amplification. Simple mechanical design. Poppet operated—not sensitive to dirt clogging. Output shaft will accept 1½° misalignment. Inherently stable.

"VAPOFLASH" Temperature Measuring Probe

A high temperature measuring element intended primarily for gas turbine applications. Provides proportional pneumatic output for 100° F. change in gas temperature. Connection of several units in parallel for averaging permits control of exhaust gas temperatures by variation of exhaust nozzle area, afterburner fuel flow, main engine fuel flow, or other dependent variable. **OPERATING RANGES:** 1,000° to 1,500° F.

Alternate style (Vapoflash Thermal Switch) provides actuation of electrical contacts within the range of 1,000° to 1,500° F.

Pneumatic Exhaust Nozzle Actuator, Type 141F14

Actuators are spaced equally around the tail pipe of a turbojet engine. Use compressor discharge pressure directly to position the exhaust nozzle. Actuator tandem four-piston design provides very high forces within small cross-sectional area. Synchonizing valves act to equalize position of driving points around exhaust nozzle. **EACH ACTUATOR:** 5,000 lbs. force with air at 200 psi. **INLET AIR TEMPERATURE:** 935° F. max. **BORE:** 3". **BARREL LENGTH:** 31.5". **MATERIALS:** Stainless steel, bronze.

MAXWELL MANNING & MOORE INC. TRADE MARK

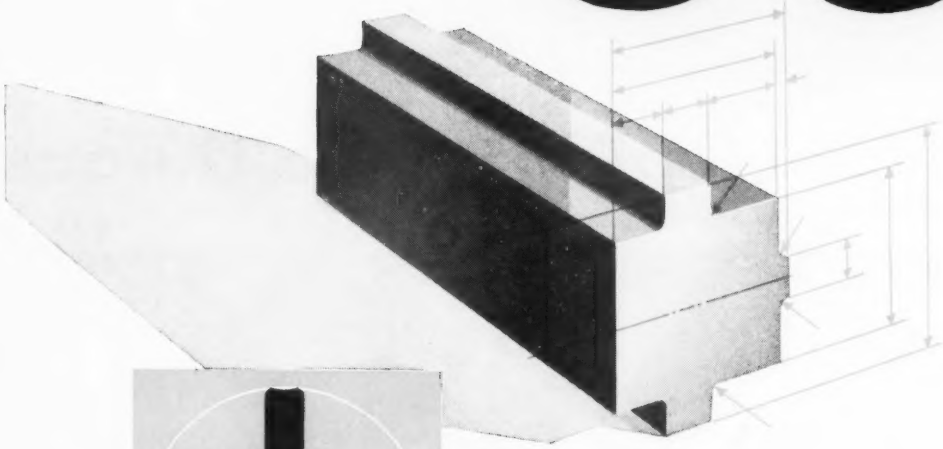
MANNING, MAXWELL & MOORE, INC.

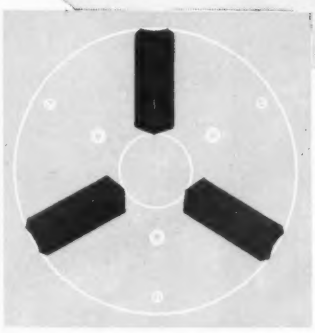
AIRCRAFT PRODUCTS DIVISION • DANBURY, CONNECTICUT • INGLEWOOD, CALIFORNIA

OUR AIRCRAFT PRODUCTS INCLUDE: TURBOJET ENGINE TEMPERATURE CONTROL AMPLIFIERS • ELECTRONIC AMPLIFIERS PRESSURE SWITCHES FOR ROCKETS, JET ENGINE AND AIRFRAME APPLICATIONS • PRESSURE GAUGES THERMOCOUPLES • HYDRAULIC VALVES • JET ENGINE AFTERBURNER CONTROL SYSTEMS.

J&L hot extruded, cold drawn chuck jaw section reduced milling cost

35%





Manufacturer reports, "We are extremely pleased with this purchased 'extruded' jaw stock. We now enjoy a 35% cost reduction on our jaw milling operations . . . and the surprising straightness of the extruded bars improves our product."

Here's how these exclusive J&L steel sections can reduce your costs:

1. Eliminate machining and finishing operations.
2. Reduce scrap losses almost to zero.
3. Eliminate cost of casting and forging intricate sections.
4. Reduce inventories because extrusions are quickly available.

Investigate this new production technique for your shape profiles—within present limits of a design which can be inscribed in a three-inch circle. You'll surely boost production, cut over-all cost. For complete details write to the Jones & Laughlin Steel Corporation, Dept. 404, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

VISIT
the Jones & Laughlin
Booth No. 112 at the
Western Metals Show
in Los Angeles
March 25-29, 1957

Jones & Laughlin
STEEL ... a great name in steel

How to cool a pilot in the Thermal T

The Douglas X-3, used in heat dispersion studies.

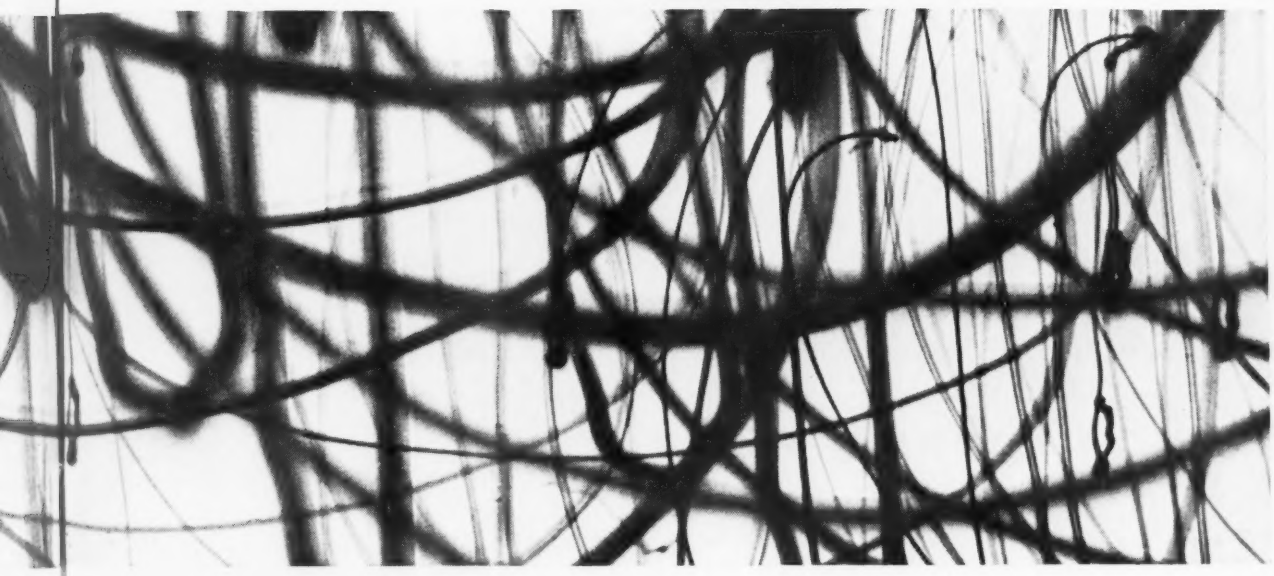
With aircraft that top 1000 mph now in military service, the problem of ***heat dispersion*** gets growing attention from Douglas engineers.

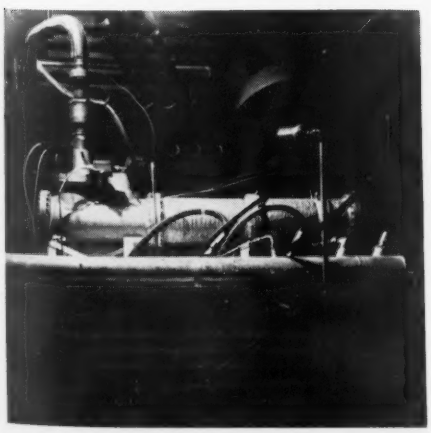
Once called the heat barrier, science now uses a more accurate term, *thermal thicket*. The faster you fly through the earth's atmospheric blanket, the further into the thicket you get . . .

At Mach 2, twice the speed of sound, a plane's skin temperature can reach 275°F. At Mach 3 it leaps to 650°F, and at Mach 5 hardened steel wilts like lettuce . . .

Douglas is attacking this heat problem on many fronts. Air conditioners powerful enough to cool a theater were tested in the famous X-3 research plane seen at left. In current Douglas missiles, amazing advancements are being made in the design of heat-resisting materials and structures. This knowledge will speed the solution of the thermal thicket problem for piloted aircraft.

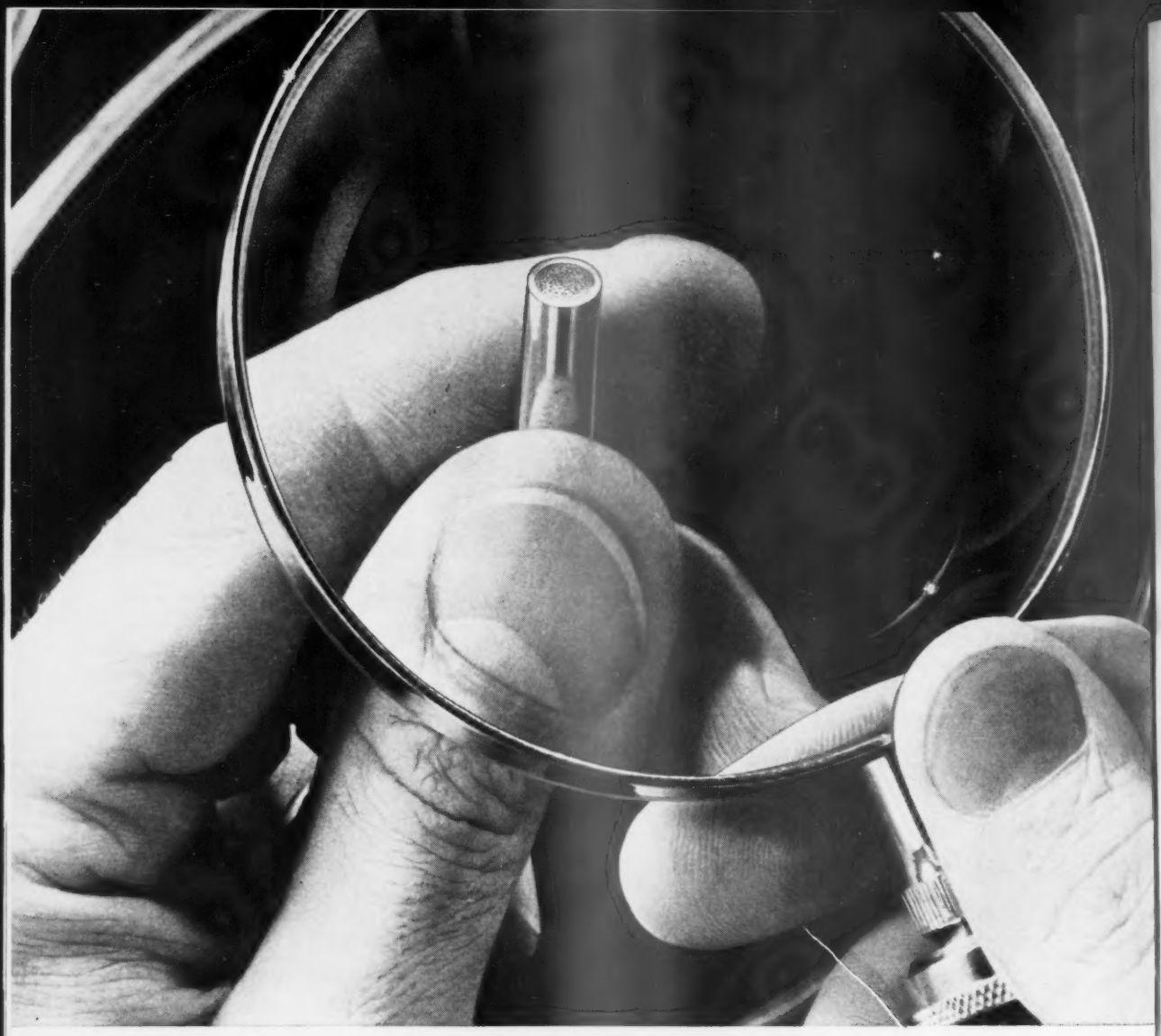
Thicket





The Douglas Aero-rotor, an instrument that blasts out high velocity gas at temperatures upward of 3000 degrees Fahrenheit, helps in research for materials to withstand high temperatures and jet velocity erosion. Other work now on the boards at Douglas ranges from designs for the practical application of atomic power to the complete design and building of intercontinental missiles — and even includes the engineering for a space platform first considered as early as 1946.

Depend on
DOUGLAS
first in Aviation



UNIQUE COPPERPLY® WIRE . . . *unique advantages!*

● National-Standard Copperply is unique because its heavy copper jacket is bonded to a steel wire core by a continuous *electroplating* process. This results in precise concentricity and permits closely controlled coating thickness. It also permits the use of core steels in a wide range of analyses.

The coating is so uniform and the bond so permanent that Copperply can be twisted, bent, flattened, stranded, woven or even roll-threaded without the slightest danger of rupturing the coating or otherwise exposing the core. Thus Copperply's extreme uniformity and permanence mean prolonged service life and maximum protection against rust, regardless of forming or service requirements.

The uses for this unique new wire are many. They range from high strength communications line and electronic applications to wire for non-rust masonry ties and decorative jewelry chain—*wherever* the combined qualities of copper and steel can work to advantage.

Name the use you have in mind and let National-Standard help you work out details. It's part of our unusual service.

NATIONAL NS NATIONAL-STANDARD Company NILES MICHIGAN **STANDARD**

DIVISIONS: NATIONAL-STANDARD, Niles, Mich.; *tire wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *high and low carbon specialty wires*
WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*

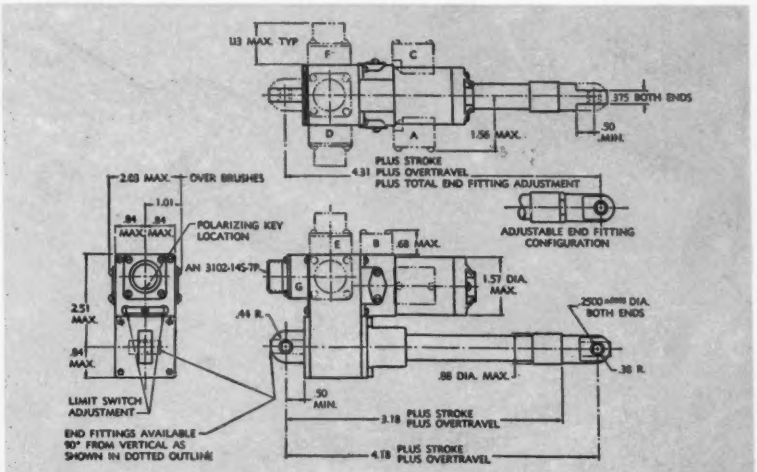
THE INFORMATION ON THIS PAGE IS TYPICAL OF THE DATA YOU WILL FIND IN THE NEW AIRBORNE CATALOG

650 LB. LINEAR ACTUATOR

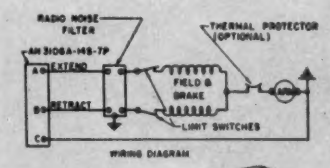
ONE OF OUR NEW SERIES OF HIGH-PERFORMANCE ACTUATORS

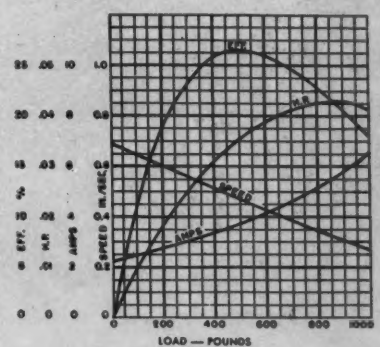
GENERAL ENGINEERING DATA:

1. 26-volt dc split field, series wound, reversible, intermittent duty motor with magnetic brake. Available with thermal overload protector.
2. Unit includes radio noise filter, limit switches externally adjustable through entire length of stroke, positive overtravel stops, overload clutch and antirotation device.
3. Maximum operating load—650 lb.
   Ultimate static load—1500 lb. compression for 12 in. maximum extended length.
4. Weight 1.75 lb.
   Plus 0.04 lb. x stroke in inches.
   Plus 0.04 lb. for thermal overload protector.
5. Dimensional tolerances ±.03 in., unless otherwise specified.
6. Dimensions given are minimum lengths for zero stroke. To determine minimum length for required stroke, add stroke, plus stroke overtravel, plus total end-fitting adjustment.
7. Available with 115-volt, 400-cycle single phase motor, ball-bearing screw jacks, load-sensing switches, position transmitters, position switches.



OPTIONAL LOCATIONS	
THERMAL PROTECTOR	CONNECTOR
A	D
B	E
C	F
	G





TYPICAL PERFORMANCE 26 v d.c.

L16 MODEL
wt. 1.75 lb.

LINEATOR® • ROTORAC® • TRIM TROL® • ROTORETTE® • ANGLGEAR ROTOLOK

AIRBORNE®

AIRBORNE ACCESSORIES CORPORATION

HILLSIDE 5, NEW JERSEY

Represented in Canada by: WINNETT BOYD LIMITED • 745 Mt. Pleasant Rd., Toronto 12, Ont.

NEW AIRBORNE CATALOG
Contains full information on the Airborne line of electro-mechanical actuators, feel systems, and electric motors. Write us for your free copy today.

IN AIR TURBINE DRIVES

WHEN PERFORMANCE COUNTS COUNT ON STRATOS

Constant speed air turbine drives are a Stratos specialty – an outstanding feature is their ability to hold speed within ± of ¼ of 1% from no load to overload conditions.

Particularly significant are the safety precautions designed into these rugged units. Besides an inherently sound design, each model incorporates an integral overspeed protection system – independent of the governing system – which shuts down the turbine mechanically. Overspeed trips are of several types – some resettable in flight – so that the best arrangement for each installation can be selected.

For additional information on Stratos' line of air turbine drives, write to:

STRATOS

A DIVISION OF FAIRCHILD ENGINE & AIRPLANE CORPORATION

Main Plant: Bay Shore, L. I., N. Y.
West Coast Office: 1355 Westwood Blvd., Los Angeles, Calif.
Western Branch: 1800 Rosecrans Ave. Manhattan Beach, Calif.

Model TP25-1, for driving a 15 kva alternator

IAS News Notes

March 1957

THIRD EDITIONS of two IAS publications - "The Engineering Profession in Aviation," popular vocational guidance manual, and the Giannini Film List, are available at National Headquarters. Revisions in the manual include a larger college curricula section and a list of university wind tunnel installations. The new Giannini catalog records 16mm films and where they may be borrowed.

IAS COUNCIL on January 28 approved filing of an application for membership in the Engineers' Council for Professional Development, a conference of cooperating engineering groups.

TWO MORE FIRMS to join the IAS Corporate Member family are Liberty Aircraft Products Corporation - headquarters at Motor Avenue, Farmingdate, L.I., New York, and, Vitro Corporation of America, Thieblot Aircraft Company Division, located at Bethesda, Md.

NATIONAL MEETINGS CALENDAR

3/14-15	Flight Propulsion Meeting, (Classified), Hotel Carter, Cleveland.
6/17-20	National Summer Meeting, Biltmore Hotel, Los Angeles, Calif.
8/6-10	Naval Aviation Meeting, U. S. Grant Hotel, San Diego, California.
9/1-15	Sixth Anglo-American Aeronautical Conference, Royal Aeronautical Society and IAS, London and Folkestone, England.
10/21-22	Canadian Aeronautical Institute-IAS Meeting, Montreal, Canada.
11/7-8	Weapons System Management Meeting, Statler-Hilton Hotel, Dallas, Texas.
12/17	Wright Brothers Lecture, Dept. of Commerce Auditorium, Washington, D.C.
1/27-31	Twenty-Sixth Annual Meeting, Sheraton-Astor Hotel, New York.

JOINT MEETINGS CALENDAR

3/11-15	1957 Nuclear Congress, Convention Hall, Philadelphia. Coordinated by Engineers Joint Council.
4/14-16	IRE National Symposium on Telemetering, Philadelphia, Pa.
5/13-15	IRE National Conference on Aeronautical Electronics, Dayton, Ohio. IAS Session on Cooling.
5/27-29	National Telemetering Conference, Hotel Cortez, El Paso, Texas. Sponsored by IAS, ISA, and AIEE.
6/19-21	1957 Heat Transfer and Fluid Mechanics Institute, California Institute of Technology, Pasadena. Cosponsored by IAS.

I A S News Notes (con't.)

REGIONAL STUDENT CONFERENCES

Mar. 29-30 Northeastern: Princeton University, Princeton, New Jersey.

Apr. 8 Indianapolis: Purdue University, West Lafayette, Indiana. Sponsored by Indianapolis Section of IAS.

Apr. 18-19 Southeastern: Atlanta, Ga.: North Carolina State College is host. Sponsored by Atlanta Section of IAS.

Apr. 24-26 St. Louis: St. Louis, Missouri. Sponsored by St. Louis Section.

Apr. 25-27 Texas: Fort Worth. Sponsored by Texas Section.

May 2-3 West Coast: Los Angeles. Sponsored by Los Angeles Section.

May 3-4 Middle Atlantic: University of Virginia, Charlottesville, Va.

May 7 Detroit: Wayne State University. Sponsored by Detroit Section.

SECTION MEETINGS CALENDAR

Mar. 6 Wichita Section: Dinner Meeting, Broadview Hotel, 7 p.m. (Social Hour at 6:30, sponsored by Beech Aircraft Corp.) "Guided Missiles and the Weapons System Concept" by Allan J. Summers.

Mar. 9 Texas Section: Field trip to Duncanville Radar Station.

Mar. 11 Indianapolis Section: Dinner Meeting, Indiana University Medical Center, 6:30 p.m. "Survival at Extreme Altitudes" by Major Arnold Beck.

Mar. 12 Hampton Roads Section: Specialist Meeting, NACA East Projection Room, Langley AFB, 8 p.m. "Engineering Test Pilot's Report on the Vertical Riser" by "Skeets" Coleman.

Mar. 12 Washington Section: Dinner Meeting, Occidental Restaurant, 6 p.m. "Future Technical Trends in Air Transportation" by G. F. Worley.

Mar. 13 Texas Section: Classified Specialist Meeting: "Armament."

Mar. 19 Hagerstown Section: Specialist Meeting, American Legion Home, 7:30 p.m. Marvin K. Strickler on aviation education.

Mar. 21 Dayton Section: Dinner Meeting, Van Cleve Hotel, 6:30 p.m. "Crash Survival Research" by G. Merritt Preston.

Mar. 29 Texas Section: Joint Dinner Meeting with American Helicopter Society.

IAS News

A Record of People and Events of Interest to Institute Members

Annual Business Meeting of the Institute

Reports of President, Treasurer, and Director

THE TWENTY-FIFTH ANNUAL MEETING of the members of the Institute was held at the Hotel Sheraton-Astor, New York, on January 30, 1957. E. R. Sharp, President, presided.

Elmer A. Sperry, Jr., Teller, reported that he had received and counted 1,256 valid proxies for voting at the Annual Meeting—a quorum of the voting membership.

The Secretary reported that L. B. Richardson, Chairman of the Nominating Committee, was unable to attend the meeting and that he had requested the following members be placed in nomination for election to vacancies on the Council:

Mundy I. Peale, Edward R. Sharp, Edwin E. Aldrin, Lt. Gen. Laurence C. Craigie, USAF (Ret.), Roy E. Marquardt, Earl D. Osborn, and Preston R. Bassett, for a term of 1 year each; William B. Bergen, Victor E. Carbonara, Jack S. Parker, Henry J. E. Reid, and Edward C. Wells, for a term of 3 years each; Raymond C. Sebold for a term of 2 years; and the following area councilors for a term of 1 year each: Eastern Area—Joseph J. Jerger and Earle Stewart; Central Area—John D. Akerman and Maurice J. Zucrow; Western Area—Smith J. DeFrance and George R. Mellinger. On motion duly made, seconded, and carried, they were unanimously elected. The following were nominated and elected in like manner to serve on the Nominating Committee for 1957: C. H. Colvin, Chairman; Wellwood E. Beall, E. H. Heinemann, Jerome Lederer, C. J. McCarthy, Clark B. Millikan, Raymond C. Sebold, and T. P. Wright.

The Annual Reports of the President, Treasurer, and Director were read and approved. (See the following pages for the complete reports.)

The Secretary presented a list of honors conferred by the Institute in 1956 as follows:

The Octave Chanute Award to A. M. "Tex" Johnston, Chief of Flight Test, Boeing Airplane Company; the John Jeffries Award to Ross A. McFarland, Associate Professor of Industrial Hygiene, Harvard University; the Robert M. Losey Award to Ross Gunn, Director of Physical Research, U.S. Weather Bureau; the Sylvanus Albert Reed Award to Clarence L. Johnson, Vice-President—Engineering and Research, Lockheed Aircraft Corporation; the Lawrence Sperry Award to George F. Jude, Director—Flight Control Engineering, Sperry Gyroscope Company; the Minta Martin Aeronautical Student Fund-National Paper Awards to: Graduate Division—Ely S. Levinsky, University of Washington; Undergraduate Division—Richard F. Weick, Agricultural & Mechanical College of Texas; and the Wright Brothers Lecturer, Sir Arnold Hall, who spoke on "Some Comments on Current Aviation Topics."

Honorary Fellowships in the Institute to: American—Harry F. Guggenheim, Senior Partner, Guggenheim Brothers; Foreign—Air Commodore F. R. Banks, a Director, The Bristol Aeroplane Company, Limited, Bristol, England.

Fellowships in the Institute to: Raymond L. Bisplinghoff, Professor—Aeronautical Engineering, Massachusetts Institute of Technology; Major Gen. Albert Boyd, USAF, Deputy Commander, Weapon Systems, Air Research and Development Command; Arthur Roderick Collar, Professor—Engineering, and Dean of the Faculty of Engineering, University of Bristol, England; Antonio Ferri, Director, Aerodynamics Laboratory, Polytechnic Institute of Brooklyn; Joseph Kaplan, Professor of Physics, University of California at L.A., and Chairman, U.S. National Committee, International Geophysical Year; George C. Martin, Chief Engineer, Seattle Division, Boeing Airplane Company; Courtland D. Perkins, Chief Scientist, USAF; Allen E. Puckett, Director—Operations, Weapon Systems Development Laboratories, Hughes Aircraft Company; Jean A. Roche, Air Force Development Field Representative, ARDC, at NACA, Langley; Fritz Schultz-Grunow, Professor, Technische Hochschule, Institut für Mechanik, Aachen, Germany; Stewart Scott-Hall, Scientific Advisor, Air Ministry, England; H. Guyford Stever, Associate Dean, School of Engineering, and Professor of Aeronautical Engineering, Massachusetts Institute of Technology; Charles H. Zimmerman, Assistant Chief, Stability Research Division, NACA, Langley Aeronautical Laboratory.

The Secretary announced that the Council had elected the following officers of the Institute for 1957: President, Mundy I. Peale; Vice-Presidents, Edwin E. Aldrin, Lt. Gen. Laurence C. Craigie, USAF (Ret.), Roy E. Marquardt, and Earl D. Osborn; Treasurer, Preston R. Bassett; Director, S. Paul Johnston; Secretary, Robert R. Dexter; and Controller, Joseph J. Maitan.

ROBERT R. DEXTER
Secretary

President's Report—1956

I AM MOST HAPPY to report that in 1956 the Institute of the Aeronautical Sciences has made sound gains in all its many activities and has completed another fiscal year in the black. The Director of the IAS in his Report and the Treasurer's Report which follow mine show in complete detail the year's activities and results.

With no national campaign to recruit new members, the IAS continues its rapid growth in size, importance, and prestige. There has been gratifying progress in upgrading qualified members and in attracting student members.

The attendance at meetings continues to increase until we have become sorely cramped in most of our customary meet-

IAS Officers for 1957

STAFF OFFICERS FOR 1957

S. Paul Johnston, Director

Robert R. Dexter, Secretary

Joseph J. Maitan, Controller

PRESIDENT
Mundy I. Peale
President
Republic Aviation Corporation

VICE-PRESIDENT
Edwin E. Aldrin
Aviation
Consultant

VICE-PRESIDENT
Lt. Gen. Laurence C. Craigie
USAF (Ret.)
Director, Hydro-Aire, Inc.

VICE-PRESIDENT
Roy E. Marquardt
President
Marquardt Aircraft Company

VICE-PRESIDENT
Earl D. Osborn (*Left*)
Chairman of the Board
Edo Corporation

TREASURER
Preston R. Bassett
Consultant

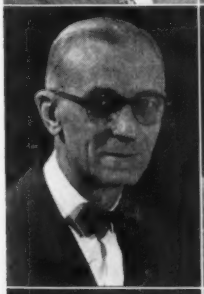
Newly Elected Members of the

INSTITUTE COUNCIL

EASTERN AREA, 1-year term

Joseph J. Jerger
Consulting
Engineer

Earle Stewart
Staff Engineer
Vertol Aircraft Corp.



CENTRAL AREA, 1-year term

John D. Akerman
Prof. & Head, Dept. Aero. Engrg.
Dir., Rosemount Aero. Labs.,
Inst. of Technology, Univ. of Minnesota

Maurice J. Zucrow
Professor
Gas Turbines and Jet Propulsion
Purdue University

WESTERN AREA, 1-year term

Smith J. DeFrance
Director
Ames Aeronautical Lab., NACA

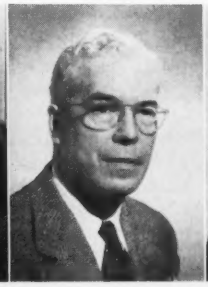
George R. Mellinger
Chief, Engrg. Flight Test
North American Aviation, Inc.

REGULAR COUNCIL MEMBERS, 3-year term

William B. Bergen
Executive Vice-Pres.
The Glenn L.
Martin Co.

Victor E. Carbonara
President
Kollsman
Instrument Corp.

Jack S. Parker
Vice-President
General
Electric Co.



Henry J. E. Reid
Director
Langley Aeronautical
Lab., NACA

Raymond C. Sebold
Vice-Pres., Engrg.
Convair, A Division of
General Dynamics
Corp.

Edward C. Wells
Vice-President
Engineering
Boeing Airplane Co.

ing quarters. I think this is a direct tribute to the excellence of planning of the technical meetings. How these meetings can be accommodated in the future at the present rate of growth poses real problems for future planners.

The Eleventh Annual National Aircraft Propulsion Meeting in March at Cleveland drew capacity attendance despite the need for confidential security clearances. In order to perform an even greater service to its members in this key part of aviation, the next propulsion meeting in Cleveland to be held in March, 1957, has already been planned as a 2-day meeting and will require secret clearance.

The Third Turbine-Powered Air Transportation Meeting at San Diego in August was also a great success.

The Annual Summer Meeting at Los Angeles in June was highlighted by a dinner paying special tribute to Dr. Theodore von Kármán who, as much as any man living, is beloved and respected by the entire aviation industry for his great contributions in the fields of science and teaching and for his tireless efforts to advance aviation.

Of particular interest has been the Institute's increased foreign activities. In Toronto last November, the Third International Meeting was held at which the growing Canadian Aeronautical Institute played host to the IAS. Participation of the IAS Director and Secretary at AGARD meetings in Munich, Brussels, and Venice during 1956 also laid the groundwork for active discussions being held in conjunction with this annual meeting for the purposes of exploring a new and greater international aviation activity. Meanwhile plans are being formalized for the Sixth International Aero Conference to be held jointly by the RAeS and IAS at London and Folkestone, England, in 1957. The international prestige of the IAS has never been greater.

One of the most important activities of the Institute has been its vocational guidance which serves to attract qualified high school students into aviation. This past year saw the wide distribution to the high schools of an excellent brochure, *Your Career as an Engineer in Aviation*. The enthusiastic response to this booklet should do much to aid in the long-range recruiting efforts of the entire industry.

The properties of IAS have benefited from careful management during 1956 which accomplished necessary maintenance and re-equipping of the headquarters building in New York, a profitable addition to the size of the Los Angeles building, and improvements in the equipment and income status of the San Diego building.

We have all been saddened by the recent death of Lester Gardner, a great pioneering editor and Founder of the IAS. The passing of Glenn L. Martin, one of the Institute's greatest benefactors, of Lawrence D. Bell, and of William E. Boeing, Sr., brings to a close their colorful pioneering careers, but their great accomplishments will serve as an enduring monument to the new pioneers on new frontiers of flight.

It has been my great pleasure to visit many interesting Section meetings of the Institute during my year in office and also to participate in its special events such as the classified tours in the Guided Missile Program aboard the U.S.S. "Boston" and at Holloman Air Force Base and White Sands Proving Grounds.

Such activities, together with the contract literature abstract service, the increased editorial content of the JOURNAL and AERONAUTICAL ENGINEERING REVIEW, the Giannini Film Library, etc., constitute extremely valuable services to IAS members, services that help to advance their professional skill and ability. I urge that you avail yourself of these worthwhile services.

I have been much impressed with the tireless energy and effectiveness of the Director, his excellent staff, the Council, and those members of Sections and Student Branches who have collectively made possible the extensive and progressive activities of the IAS. It has been gratifying to me to see the work of the IAS done so competently and with a lack of fanfare and a minimum of time-consuming committee meetings unparalleled in the management of a large technical society.

No one of us can look ahead to the certainty of successful accomplishment of the IGY satellite program and of other advanced aviation projects of great importance to our country without a growing excitement, an increased intensity in our own personal efforts, and a more confident outlook at the broad scope of challenges that lie ahead.

It has been a distinct honor to serve the Institute in this high office during such progressive times. Now, although I hand the gavel to my successor, I will in no way diminish my continuing support of the worthy purposes of the Institute.

E. R. SHARP
President, 1956

Treasurer's Report—1956

AS TREASURER I am pleased to report a satisfactory condition of finances at the end of a strenuous year. It will give the membership satisfaction to know that the IAS was able not only to expand existing services but also to provide new aids to the engineering profession, all within the limits of basic dues unchanged since the late 1940's.

Most of the Institute's normal financial activities were conducted in a routine manner, with a year-end surplus (after Council-authorized reserves) being transferred to the General Fund as can be seen from the accompanying financial statement.

Revenues from IAS publications were higher than last year, as were expenses. The increase in net income from publication activity was $2,600. Additional advertising in the AERONAUTICAL ENGINEERING REVIEW accounted for the bulk of the increase. The JOURNAL OF THE AERONAUTICAL SCIENCES income was increased but was immediately allocated to expanding the editorial content of that publication. The AERONAUTICAL ENGINEERING CATALOG, an annual, operated profitably.

Meeting and library costs were increased by $10,000 as a result of an expansion of local and national meetings together with an expanded library acquisition program. Not only are periodicals and books being secured for the library but also current unclassified reports generated through military contracts which ordinarily receive a limited distribution and circulation.

The Institute itself has two nonprofit Government contracts to provide essential information to the Air Research and Development Command. The Technical Film Catalog project previously reported has been extended to June 30, 1957. The International Abstract contract was initiated in December, 1956, to review worldwide technical literature on a joint IAS-Government participation cost basis.

The office furniture and equipment modernization program was continued. Also continued was the refurbishing of the New York building together with necessary maintenance.

In San Diego the second floor of the building was converted into usable office space which increased building income. Through the excellent efforts of the Section officers and staff, the net operating loss was negligible. Greater utilization of the auditorium is anticipated through the availability of a caterer now established in the building to serve luncheons, dinners, and special functions.

An addition to the Los Angeles building will be occupied by the AIA under a 5-year lease and will be amortized during that period. The operation of the Los Angeles building under the supervision of local officers, committees, and staff ended the year with a net income after expenditures for minor building improvements and equipment.

INSTITUTE OF THE AERONAUTICAL SCIENCES, INC.

Statement for the Fiscal Year October 1, 1955, to September 30, 1956

Consolidated Balance Sheet and Operating Statement

ASSETS

Unrestricted:		
Cash on Deposit	$ 22,817.46	
Accounts Receivable	68,163.03	
Advances on Intrafund Accounts	41,328.76	
Deposits and Prepayments	29,561.59	
Investments	502,254.81	
Furniture and Fixtures	5,000.00	
Total Unrestricted Assets		$ 669,125.65
Specific:		
The Sherman M. Fairchild Fund	$ 6,626.15	
The G. M. Giannini Fund	2,807.33	
The Guggenheim Fund	392,060.33	
The Paul Kollsman Fund	69,000.00	
The Vernon Lynch Award Fund	37,670.31	
The Minta Martin Aeronautical Student Fund	515,158.68	
The Sylvanus Albert Reed Award Fund	13,571.90	
The Lawrence Sperry Award Fund	13,480.00	
The Water-Based Aircraft Fund	20,162.00	
The Los Angeles Building Operating Fund	18,267.79	
The Pacific Aeronautical Library Fund	29,483.05	
The San Diego Building Operating Fund	12,688.36	
Total Specific Assets		$1,130,975.90
Facilities (at Cost):		
Los Angeles	$427,640.20	
New York	220,951.21	
San Diego (land leasehold)	176,706.11	
Total Facilities		$ 825,297.52

LIABILITIES AND RESERVES

Unrestricted:		
Accounts Payable and Deposits	$ 81,359.52	
Deferred Credits to Income	106,825.42	
Deferred Income—San Diego Building	15,842.77	
Deposit—Pacific Aeronautical Library	12,000.00	
Reserves	232,402.22	
General Fund—Balance September 30, 1956	220,695.72	
Total		$ 669,125.65
Specific Funds (see Assets)		$1,130,975.90
Buildings, Land, and Equipment (see Assets)		$ 825,297.52

Statement of Income & Expenses

Income:

Advertising Revenue	$395,839.74	
Dues and Entrance Fees	260,687.07	
Subscriptions and Related Accounts	90,443.18	
Investment (unrestricted)	29,683.36	
Miscellaneous	20,909.76	
Total Income		$797,563.11

Expenses:

Publications	$430,458.55	
Salaries	175,096.92	
Employees Retirement Fund, Reserve and Social Security	43,478.22	
Libraries and Related Activity	35,107.29	
Meetings and Travel	34,814.99	
Building Maintenance and Reserve for Repairs	29,598.16	
Printing, Postage, Communication, and Equipment	22,223.48	
Office Supplies and Expense, Insurance	15,182.09	
West Coast Offices (net)	5,620.54	
Miscellaneous	4,647.42	
Total Expense		$796,227.66
Net to General Fund		$ 1,335.45

The operation of the Pacific Aeronautical Library was normal with the net operating income transferred to the PAL Surplus account.

Two significant changes are to be noted on our Balance Sheet:

(1) A legacy in the amount of $250,000 under the terms of the will of Glenn L. Martin was received in June which was added to the existing Minta Martin Aeronautical Student Fund, bringing the total principal of that Fund to $500,000. The income is used in the manner prescribed by the donor.

(2) An anonymous donor also established the Water-Based Aircraft Fund with a capital endowment of $20,000 to provide annual awards in this field.

After a careful analysis and review of market conditions, the Finance Committee, which meets quarterly, invested these additional funds and included them in the Institute's general investment portfolio. This portfolio had a value of $1,988,540 on September 30, 1956, which was $365,916 in excess of the original cost and/or book value. The Finance Committee is to be commended for its excellent management of IAS investments.

A conservative budget for 1956–1957 has been presented to, and approved by, the Council. It is anticipated that the balanced budget will be met.

The books of the IAS were audited by Harris, Kerr, Forster & Company. A copy of their complete report is available to members at the national office.

SHERMAN M. FAIRCHILD
Treasurer

Director's Report—1956

AS OF THE END OF 1956 the Institute completed its first quarter of a century of service to aeronautics in America. On all fronts, no year in IAS history had been more active or more rewarding, and at no time had future prospects in all areas of interest seemed brighter. We have expanded our interests in all phases of the aeronautical sciences, and we are now on the verge of more active extension of these activities on an international scale.

During the past few years we have come a long way from the classical concept of the aeronautical engineer as a man who is concerned largely with patterns of airflow in wind tunnels or of behavior of stick-and-wire structures under stress. The aeronautical sciences today draw on practically every field of scientific endeavor, and the Institute is keeping pace. A glance at our current programs and publications will indicate that we are dealing with the most sophisticated studies in mathematics, in electronics, in rocketry, and in aeromedicine and human engineering, and we are now reaching into the areas of atomic and nuclear phenomena. That we are meeting the needs of our members for service in such fields is reflected in a record of increasing membership, increasing Section and Branch activity, and favorable reaction to our publications.

We are aware that we must not only satisfy the requirements of the most advanced research worker but also serve the aeronautical engineering student. Beyond that, we have come to realize that we also have an obligation to create interest in the aeronautical sciences at the high school level. Consequently a substantial part of our activities of the past year has been directed toward encouraging high school students to qualify themselves to enter the aeronautical engineering and allied professions.

To carry on such programs at accelerated rates has imposed ever-increasing loads on staff and on budget. In both departments, however, the requirements have been met. Our staff has risen to the challenge, and, thanks to continuing fiscal support from members and from industry, we have been able to perform all necessary services and end up the year with something to spare, as the Treasurer's Report has indicated.

Membership

In 1956, the Membership Committee overhauled the entire membership structure, considerably strengthening our position. Highlights were consolidation of grades, tightening of qualifications, and standardization of dues.

As will be noted from the attached tabulations, the 1956 growth in membership (1,124) is far and away the largest on record. Another record high was achieved in new applications received, while a steady upward trend is being realized in regrade applications. Resignations and "dropped" members are the lowest in 10 years. In 1955, the net increase in membership exceeded all combined losses for the first time. In 1956, the net was more than double the losses. All these figures are believed to be direct benefits of strong Section activities.

Sections

For the eleventh consecutive year, all aspects of Section operation reached new highs. Section membership increased by over 800 in 1956. It continues to represent over 80 per cent of total IAS membership and is 86 per cent of the United States total membership of 11,350. The number of Section meetings increased from 267 to 275 in the past year.

Two meetings of Section Chairmen were held, one in New York during the Annual Meeting in January and one in Los Angeles during the Summer Meeting in June. Five issues of the Section Chairmen's *Newsletter* were published in 1956. The *Guide for Section Officers* was revised, and the improved version is in the hands of each officeholder.

All Sections now have Student Activities Committees (or their equivalent) and are rendering student aid in areas ranging from career clinics to television programs. Six Sections put on television shows in 1956. The Sections were also the prime distributors of the IAS guidance publication, *Your Career as an Engineer in Aviation*.

The First Minta Martin Lecture was presented in 1956 at meetings sponsored by the Boston, Cleveland-Akron, Washington, Baltimore, and Los Angeles Sections.

Student Activities—General

The highlight of 1956 student work was the publication of the IAS-created booklet, *Your Career as an Engineer in Aviation*, in September, climaxing a year's work in planning and development; 125,000 copies were printed, and 100,000 copies were distributed.

Two graduate students are being provided for during the current year at Princeton University under the auspices of the IAS Flight Test Engineering Fellowship.

A 5-page "Corrections and Addenda" to the September, 1955, edition of the *Giannini Film List* was published and

TABLE 1
Membership Breakdown—Comparisons by Calendar Year
(January 1, 1957)

	12/31/54	*12/31/55*	*12/31/56*
Temporary Honorary Members	16	16	16
Honorary Fellows	30	32	30
Fellows	199	198	202
Associate Fellows	829	926	1,041
MEMBERS	4,212	4,668	5,284
Associate Members	482	502	546
Technical Members	4,410	4,633	4,981
Total Graded	10,178	10,975	12,099
Student Members	3,110	2,984	3,908
Totals	13,288	13,959	16,007

TABLE 2
Sections and Branches
(January 1, 1957)

	1946	*1947*	*1948*	*1949*	*1950*	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*
Sections	13	17	19	19	23	24	25	26	24	27	27
Section Meetings	72	92	121	126	144	181	181	237	241	267	275
Section Members	4,166	4,734	5,032	5,718	6,436	7,143	7,379	8,408	8,411	9,043	9,837
Branches	38	51	60	67	70	71	71	69	71	73	74
Branch Meetings	210	277	327	336	317	323	350	319	366	227	313
Student Members	1,655	3,300	4,068	3,958	3,395	3,006	2,796	2,672	3,110	2,984	3,908

distributed in September, 1956. Six hundred thirty film loan requests were handled; 251 were granted and serviced in 1956.

Increases over the previous year were effected in the number of Student Branches (74), student membership (3,908), Branch Meetings (313), award winners (99), and transfers (623).

Five editions of the *Student Branch Newsletter* were published. This has now become a regular monthly publication. A reprint of the July REVIEW Editorial, "The Job Before Us," was sent to all faculty advisers.

Minta Martin Aeronautical Student Fund

In the spring of 1956, eight Regional Student Conferences were held, one each in Detroit, St. Louis, Dallas, Atlanta, Los Angeles, Indianapolis, Providence, and Washington, D.C. One new conference will be held in Tulsa in 1957.

Eleven technical papers which won first prize in the 1956 conferences were published in the *1956 First Award Papers*. Six hundred copies have been distributed to Sections, Branches, schools, libraries, and interested individuals.

Two National Awards (1955)—one graduate, one undergraduate—were presented in 1956. The two winners who have been selected from the *1956 First Award Papers* will receive engraved plaques in early 1957. Duplicate National Awards were established and presented to the schools of the National winners.

The supply of the second edition (30,000) of the *IAS Vocational Guidance Manual*, titled *A Guide to the Engineering Professions in the Aviation Industries*, was exhausted. A third and revised edition, newly titled *The Engineering Professions in Aviation*, has been prepared and is now in the hands of the printer. Publication of 30,000 copies is planned for early 1957.

Meetings

Institute meetings (including national, regional, Section, and Branch) continued to be held at a better than two-per-working-day average throughout the year. The actual figures for Section and Branch meetings will be found in the appropriate paragraphs above.

The national meetings (including those which were wholly Institute sponsored and those in which we participated) are as follows:

Jan. 23–26	IAS Twenty-Fourth Annual Meeting, New York
Mar. 9	IAS Flight Propulsion Meeting (confidential), Cleveland
Mar. 14, 15	ASME-ARS-IAS Conference on Air Cargo and Air Logistics and Thermal Barrier, Los Angeles
May 14–16	IRE-IAS National Conference on Aeronautical Electronics; IAS Session on Human Engineering, Dayton, Ohio
June 5, 6	RTCA-IAS-IRE Assembly Meeting, Boston
June 18–21	IAS Summer Meeting, Los Angeles
June 21	IAS Field Trip, March AFB, California
June 21–23	IAS-Stanford U. Heat Transfer and Fluid Mechanics Institute, Stanford U., Stanford, Calif.
Aug. 15–17	IAS National Turbine-Powered Air Transportation Meeting, San Diego, Calif.
Aug. 20, 21	IRE-AIEE-ISA-IAS National Telemetering Conference, Los Angeles
Oct. 2	IAS Classified Inspection Guided Missile Cruiser U.S.S. "Boston," Norfolk, Va.
Nov. 19, 20	IAS Classified Inspection Guided Missile Facilities, Holloman Air Development Center, USAF, and White Sands Proving Grounds, U.S.A.
Nov. 26, 27	CAI-IAS Annual Joint Meeting, Toronto, Can.
Nov. 26–28	ASME-SAE-IAS Air Cargo Session, New York
Dec. 7	Symposium on the Ecology of Air Transport (Aeromedical-Engineering Association; Institute of Transportation & Traffic Engineering & Engineering Extension, U.C.L.A.; and IAS), Los Angeles
Dec. 17	IAS Twentieth Wright Brothers Lecture, Washington, D.C.

For the coming year, the above program will be augmented by two additional major items: (1) The Sixth Conference with The Royal Aeronautical Society of Great Britain to be held in Great Britain during the first weeks of September and (2) a new national meeting sponsored by the Texas Section at Dallas in early November on the general subject of Weapons Systems. The National Turbine-Powered Air Transportation Meeting (held August 15–17 in San Diego, Calif.) will be postponed until the summer of 1958. In its place for the coming year a National Naval Aviation Meeting is scheduled for San Diego early in August.

International Activities

During the past several years the Institute has been participating in international aeronautical affairs on an increasing scale. In addition to our biannual meetings with The Royal Aeronautical Society, we have been cooperating very closely with AGARD. Since 1953 we have attended the general assemblies and have also participated in the work of a number of the committees, particularly in documentation. In May, 1956, the Director and the Secretary attended the Guided Missile Symposium in Munich, Germany. In August and September we also participated in the General Assembly in Brussels, and in September the Secretary attended the Second Missile Conference in Venice.

During the latter part of 1956, IAS Secretary Dexter was appointed a member of the AGARD Documentary Committee (he had formerly been an "Observer").

We have recently been invited to present a paper on the techniques of aeronautical reporting and publishing at the next joint meeting of AGARD's Documentation Committee and the ASLIB (the British Library Association) in England in April, 1957. This paper will be prepared jointly by the IAS Secretary and the IAS Director of Publications and will be presented by the latter.

During the course of meetings overseas a number of conferences were held

with Air Force representatives in Europe, out of which developed an extension of our ARDC International Abstracts contract (special editions in three languages for distribution in Europe).

Also, as a result of conversations with key scientific personnel in Europe, a project is under consideration to expand our international meetings program to include every country in the world in which there is aeronautical activity. Financial support for such meetings may become available under IAS auspices. A meeting of high-level aeronautical scientists under the Chairmanship of Dr. von Kármán has been set up for mid-January, 1957, to explore the possibilities. This could be one of the most important forward steps in Institute history.

Planning for the Sixth RAeS-IAS Conference was inaugurated during the summer of 1956. Meetings were held with RAeS representatives in Brussels and in London, and the details of the technical programs were agreed upon. Topics have been selected, and authors have been secured for all United States papers. In England, arrangements have been made to hold part of the meeting in London and part in Folkestone. On our part, we have made preliminary arrangements to handle the transportation and housing requirements for American delegates through a travel agency.

Relations with the Canadian Aeronautical Institute were further strengthened during the year. The third joint meeting, late in November in Toronto, was extremely successful from the point of view of both attendance and program.

Publications

Dr. William Sears of Cornell University relieved Dr. Hugh Dryden as Editor of the JOURNAL OF THE AERONAUTICAL SCIENCES in January, 1956. A 96-page-per-issue average was maintained throughout the year, and the backlog of articles on hand was considerably reduced. Publication at this level will continue. The Reader's Forum section continues to expand and has become an extremely important part of the publication. A special issue commemorating the seventy-fifth birthday of Dr. Theodore von Kármán contributed by his former United States students and associates was published in May.

The REVIEW continues to expand both editorially and from a revenue point of view. The editorial staff has been strengthened, and a continuing study has been made of its editorial content with a view toward serving the greatest possible cross section of our membership. The "yellow sheet" insert carrying the International Abstracts has now been included for a full year. It has attracted great interest both at home and abroad. Under a new ARDC contract provision, it is being expanded and will be distributed in a French and German language edition through the facilities of the USAF Brussels office.

From a business point of view, the results have been excellent. In spite of increasingly heavy competition from commercial publications (two or three new ones have appeared during the past year), we are more than holding our own in the advertising field. The earnings of the REVIEW have been largely responsible for keeping us in black figures for the current year.

The CATALOG, also facing heavy commercial competition, has continued to run on a more than break-even basis. The policy of limiting CATALOG items to strictly air-borne equipment has been maintained. The directory section has been continually up-dated.

Activities of the Sherman M. Fairchild Fund continue at a high level. During the course of the year, some 11,500 copies of our reprints or preprints were distributed, and 85 new titles were added to the list. The winning papers coming from our six Regional Student Conferences were printed under the auspices of the Minta Martin Fund.

Library Services

On the West Coast the Institute's Pacific Aeronautical Library continued its essential service to the industry of that region. Mrs. Nell Steinmetz and her small staff handled over 50,000 requests for material and grossed approximately $60,000 in income. A twice-weekly station wagon delivery service is maintained to handle material to our 70-odd subscribers in the Los Angeles area.

In the New York Library, services, acquisitions, and processing showed marked increases in activity during 1956. Particularly notable were the rises in circulation (39 per cent), photocopying (27 per cent), report acquisition (82 per cent), abstracting (21 per cent), and book annotations (90 per cent). Additional effort was expended in the direction of acquisitions, particularly in the areas of foreign reports and periodicals. This effort was aided greatly by ARDC cooperation and by publication exchanges arranged with report-producing agencies falling within the sphere of AGARD (NATO), with the IAS being designated as National Receiving Agency for reports from NATO countries. Exchanges with U.S.S.R. periodicals were also set up.

Reading Room services were active. In addition to literature searches of a minor nature, 21 bibliographies of a more formal nature were completed. Cataloging of our collections was continued throughout the year.

The Historical Section has made great inroads into the year's accumulation of photographs. Some 17,000 aircraft photographs have been identified, marked, and housed in approximately 3,500 folders—classified by manufacturer and designation. Use of the collection is good.

The Abstracts and Reviews Section, under Miss Irene Bogolubsky, operated smoothly and efficiently in the editorial preparation and production of the International Aeronautical Abstracts, in addition to the work of the regular Aeronautical Reviews Section. During December, a translator/abstractor and a typist were hired for the preparation of French and German editions, and considerable preliminary work was accomplished in connection with subject classification, editorial style, and other matters relating to the preparation of foreign-language editions.

Facilities

A major change in our physical plant during the past year was a 1,200-sq.ft. addition to the north wing of the Los Angeles building. This $15,000 job to provide additional space for the operations of our tenant, the Aircraft Industries Association, was completed and occupied in November.

A program of continuous maintenance and modernization is continuing in the New York building. Necessary outside repairs to roof and stone work were made during the year, and external iron work was repainted. Equipment modernization included the replacement of all obsolete desks, office furniture, and many files with more efficient steel equipment. Some minor rearrangement of office layout was made in the interest of improved operating efficiency.

General

Lester D. Gardner, Founder of the IAS, died on November 23, 1956, after a long illness. He had retired from participation in Institute affairs in 1946. During his later years he devoted himself to research in the historical aspects of aviation and to raising funds for worthy aeronautical purposes. He was buried in Arlington National Cemetery on November 27, 1956.

In conclusion, I would like to pay tribute to the hard-working staff of the Institute which makes all its activities possible. Few organizations can claim as well-integrated and as dedicated a group of people as that which carries on the day-to-day business of this organization. To them goes credit for the accomplishments of the past years.

S. PAUL JOHNSTON
Director

AMERICAN HONORARY FELLOW
Harry F. Guggenheim

Honorary Fellows for 1956

Honorary Fellows shall be persons of eminence in aeronautics and are elected by the Fellows and Honorary Fellows of the Institute residing in the United States. Not more than one person residing in the United States, nor more than one person residing in a foreign country, may be elected as Honorary Fellow in any one year.

FOREIGN HONORARY FELLOW
F. R. Banks

Fellowships in the Institute—1956

Fellows of the Institute of the Aeronautical Sciences shall be those who have attained a position of distinction in aeronautics and made notable and valuable contributions in one of the aeronautical sciences or aeronautical engineering.

• **R. L. Bisplinghoff**
Professor,
Aero. Engrg., M.I.T.

• **Major General Albert Boyd, USAF**
Deputy Commander, Weapon Systems, ARDC

• **Arthur Roderick Collar**
Professor, Engineering, Dean of the Faculty
of Engineering, University of Bristol, England

• **Antonio Ferri**
Dir., Aerodynamics Lab., Polytechnic Inst. of Brooklyn
Dir., Research, Gruen Applied Science Labs.

• **Joseph Kaplan**
Professor of Physics, UCLA
Chairman, U.S. National Committee, IGY

• **George C. Martin**
Chief Engineer, Seattle Division
Boeing Airplane Company

• **Courtland D. Perkins**
Chief Scientist, USAF

• **Allen E. Puckett**
Dir., Operations, Weapon Systems
Development Labs., Hughes Aircraft Co.

• **Jean A. Roche**
Air Force Development Field Rep.
ARDC, NACA, Langley

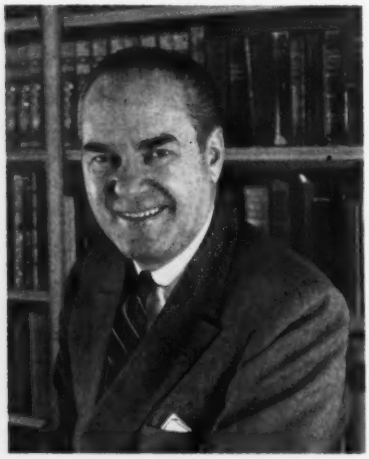
• **Fritz Schultz-Grunow**
Professor, Technische Hochschule
Institut für Mechanik, Aachen, Ger.

• **Stewart Scott-Hall**
Scientific Advisor
Air Ministry, England

• **H. Guyford Stever**
Associate Dean, School of Engineering
Professor of Aero. Engineering, M.I.T.

• **Charles H. Zimmerman**
Assistant Chief, Stability Research
Division, NACA, Langley

IAS Awards for 1956



Ross A. McFarland
Associate Professor of Industrial Hygiene
School of Public Health, Harvard University

The John Jeffries Award

This award honors the memory of Dr. John Jeffries, an American physician who, with Blanchard, the French balloonist, made the first aerial voyage across the English Channel in 1785 and on a previous flight made the earliest recorded scientific observation from the air. The award is accompanied by an honorarium. It was established by the Institute in 1940 to give recognition to the importance to aviation of scientific endeavor in the field of medicine.

Presented to Ross A. McFarland

"For outstanding contributions to the advancement of aeronautics through medical research."

Ross A. McFarland, Associate Professor of Industrial Hygiene, School of Public Health, Harvard University, receives the Jeffries Award for his many original contributions relating to human factors in the design and operation of transport aircraft. His work is unique in that it has combined basic knowledge from various biological and engineering sciences in the more effective integration of men and machines, especially modern aircraft.

Dr. McFarland's experiments on the effects of high altitude on the brain and central nervous system began in 1928 on military pilots. These and later studies aided in establishing human limits for high-altitude flight and provided basic requirements for pressurized cabins. He participated in experiments on the first air transport so equipped; his work has combined extensive field observations and laboratory studies of operating air transports in all parts of the world.

Between 1936 and 1939, Dr. McFarland participated in studies of operational fatigue in airmen during the opening of transoceanic air routes. Frequently called upon as technical adviser to manufacturing and operating companies, he developed an extensive medical program for the Pan American World Airways System.

Dr. McFarland is Director of the Commission on Accidental Trauma, Department of Defense; a Consultant to the Surgeons General of the Army and the Air Force; and a Member of the Committee on Operating Problems, NACA. He is a Member of the Institute.

Ross Gunn
Director of Physical Research
U.S. Weather Bureau

The Robert M. Losey Award

Established in 1940, this annual award honors the memory of Capt. Robert Moffatt Losey, a member of the Institute and a meteorologic officer of the Air Corps, who was killed at Dombas, Norway, April 21, 1940, while serving as an official observer for the U.S. Army. He was the first officer in the service of the United States to die in World War II. This award carries an honorarium.

Presented to Ross Gunn

"In recognition of outstanding contributions to the science of meteorology as applied to aeronautics."

Ross Gunn, Director of Physical Research, U.S. Weather Bureau, has established in a series of remarkable papers over the last several years the first really satisfactory theory of atmospheric electricity—a field in which he has conducted a number of definitive experiments.

Cited by the Secretary of the Navy in 1945 for exceptionally distinguished service in connection with development of the atomic bomb, Dr. Gunn has had a distinguished scientific career which began soon after his education at the University of Michigan and Yale University. After some teaching experience at both of his alma maters, he served for 20 years in the Naval Research Laboratory where he became Superintendent of the Mechanical and Electrical Division.

Dr. Gunn's most important contributions to research in aeronautical meteorology have been in the field of atmospheric electricity. As Director of the Army-Navy Precipitation Static Project and the Atmospheric Electricity Research Project in 1943–1947, he added greatly to fundamental knowledge of the electrical phenomena of the free atmosphere.

An inventor of instruments and specialized devices, Dr. Gunn was Director of the Air Force - Weather Bureau Cloud Physics Project in 1947–1950, was a Consultant to the C. F. Kettering Foundation in 1951–1954, and has held other posts with research groups. Dr. Gunn, born in Cleveland on May 12, 1897, also has been a Consultant to the NACA since 1943. He is a Fellow of the American Physical Society and of the IRE and a Member of the National Academy of Sciences and is active in several other societies.

Clarence L. Johnson
Vice-President—Engineering and Research
Lockheed Aircraft Corporation

The Sylvanus Albert Reed Award

The late Dr. S. A. Reed, designer of metal aircraft propellers and a Founder Member of the IAS, made an endowment to the Institute in 1933 to provide an annual award to be presented for a notable contribution to the aeronautical sciences, resulting from experimental or theoretical investigations which have had a beneficial influence on the development of practical aeronautics. The award consists of a certificate and an honorarium. The recipient is chosen by ballot of the American Honorary Fellows and Fellows of the Institute.

Presented to CLARENCE L. JOHNSON

"For contributions and leadership in solving problems in the design of supersonic airplanes and missiles, especially the thermal problems at hypersonic speeds."

Clarence L. Johnson, designer of the XF-104, reportedly the world's fastest jet fighter capable of overtaking and destroying any aircraft of any size known, is Vice-President—Engineering and Research, Lockheed Aircraft Corporation.

Mr. Johnson was graduated from the University of Michigan with a M.S. degree in Aeronautical Engineering. His career with Lockheed was begun in 1933; 5 years later he had become Chief Research Engineer and in 1952 was appointed Chief Engineer of the California Division. It was during the ensuing year that design of the XF-104 was completed—a new concept of thin straight wing design. The plane was so remarkably successful that it was ordered in quantity by the USAF.

Mr. Johnson designed the twin-engined Lockheed Electra, a design incorporating a feature which has become akin to a Johnson fingerprint—twin vertical stabilizers. His real high-speed work, however, was evidenced first in the P-38 twin-engined fighter, followed in 1943 by the P-80 jet fighter—the first jet airplane to be mass produced. Design of this aircraft was accomplished in 139 days and was of such quality that today, 14 years later, a modification is used by both the USAF and the Navy as a jet trainer. Mr. Johnson also supervised construction of the P-80.

In 1944, Mr. Johnson was instrumental in design and perfection of the four-engined Constellation.

George F. Jude
Director, Flight Control Engineering
Sperry Gyroscope Company

The Lawrence Sperry Award

This award was endowed in 1936 by the sister and brothers of the late Lawrence Burst Sperry, pioneer aviator and inventor, who was drowned in 1923, at the age of 31, after a forced landing in the English Channel. The certificate and honorarium are presented annually for a notable contribution made by a young man to the advancement of aeronautics.

Presented to GEORGE F. JUDE

"For significant contribution to the advancement of precision automatic flight control and safe all-weather flight."

George F. Jude, Director—Flight Control Engineering, Sperry Gyroscope Company, is given major credit for bringing through final development and into production last year the revolutionary SP-30 flight control system. This comprises a newly developed velocity servosystem and strategic use of angular accelerometers as responsive devices for split-second sensing of minute deviations of an aircraft from its flight reference.

Now 37, Mr. Jude began his career at Sperry in 1942 as an engineer, indoctrinating pilots and others in the use and maintenance of the A-5 automatic pilot. After several promotions, he was made responsible in 1948 for development of an all-weather flight system for the USAF. Results included development of efficient control systems for governing rate of climb and descent, air speed, flare-out, and the radio beam coupler. On being promoted on October 1, 1954, to Department Head—Bomber and Transport Flight Control Systems, Mr. Jude was able to advance the development of new engineering approaches growing out of concepts envisioned during earlier periods of high activity and accomplishment. Ten months later, he was promoted to his present position and guided to successful conclusion development of the first practical flight control system providing for either full or partial control of helicopters.

Mr. Jude's coordination and guidance of complex staff efforts during this period earned for him an industry-wide reputation for being able to undertake unusual engineering problems.

New IAS Award

WATER-BASED AVIATION

Twelve of the nation's leading figures in aeronautics were honored with the Institute's newly established Water-Based Aviation Award, presented for contributions as pioneers in the field, at the Honors Night Dinner, on January 28.

The award, designed to stimulate water-based aircraft research and development, was made possible by an anonymous donor and honors the memory of Edwin C. Musick, pioneer of overseas air transport routes. He was killed on January 12, 1938, while in command of the first commercial flight from the United States to New Zealand for Pan American.

Recipients of the award were Capt. Walter S. Diehl, USN (Ret.), a Consulting Engineer, Washington, D.C.; C. L. Egtvedt, Chairman, Boeing Airplane Company, Seattle; Jerome C. Hunsaker, Professor of Aeronautical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.; J. H. Kindelberger, Chairman of the Board, North American Aviation, Inc., Los Angeles; B. V. Korvin-Kroukovsky, Research Professor, Experimental Towing Tank, Stevens Institute of Technology, Hoboken, N.J.; I. M. Laddon, President and Chairman of the Board, Langley Corp., San Diego, Calif.; Grover Loening, Aviation Consultant of Mill Neck, N.Y.; C. J. McCarthy, Chairman of the Board, Chance Vought Aircraft, Inc., Dallas, Tex.; Capt. H. C. Richardson, USN (Ret.), a Consultant of Washington, D.C.; Capt. C. H. Schildhauer, USNR (Ret.), of California Eastern Aviation; I. I. Sikorsky, Engineering Manager of Sikorsky Aircraft Division, United Aircraft Corporation, Bridgeport, Conn.; and C. A. Van Dusen, Managing Partner, Van Dusen Engineering Co., Escondido, Calif.

The award is "for meritorious work in the design or operation of water-based aircraft leading to advances in performance or utility." One contemporary in the field will be chosen annually in future years by a Committee of Award on the basis of current achievement, and each certificate will be accompanied by an honorarium.

Minta Martin Awards for 1956

The Minta Martin Aeronautical Student Fund, operating for 3 years, saw eight regional student conferences held last year—two more than in 1955.

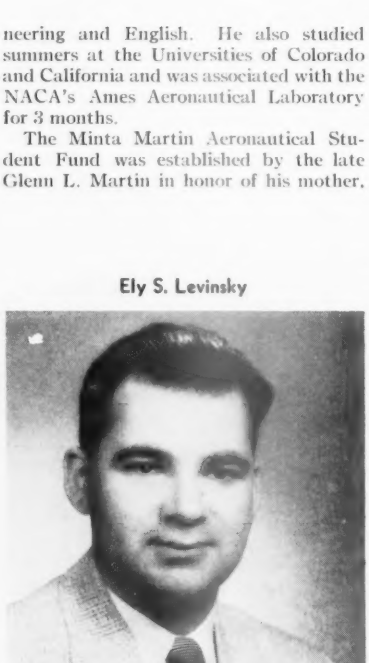
From among more than 75 technical papers written by college students and presented in competition, eleven that won top awards in 1956 have been published in a bound volume by the Institute. Two national winners were selected from this group to receive the Minta Martin National Awards.

The graduate division award went to Ely S. Levinsky, of San Diego, Calif., for his paper "Approximate Compressible Laminar Skin Friction With Favorable Pressure Gradients." A 1951 graduate of the University of Wisconsin, he received his M.S. degree in Aeronautical Engineering at the University of Washington last June. Mr. Levinsky has been an Aerodynamics Engineer at Convair, A Division of General Dynamics Corporation, since October.

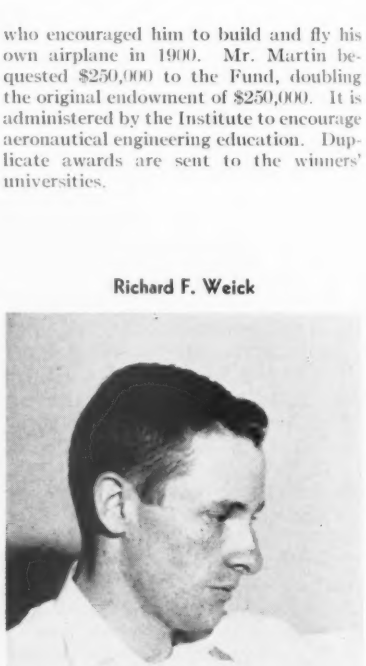
The undergraduate award went to Richard F. Weick, of Albuquerque, N.M., for a paper on "Preliminary Design Study of a Turbine-Powered Executive Airplane." A Second Lieutenant in the Air Force, he is Project Officer, 4925th Test Group (Atomic) at USAF Special Weapons Center, Kirkland AFB. Mr. Weick was graduated from the Agricultural & Mechanical College of Texas last June with Bachelor degrees in Aeronautical Engineering and English. He also studied summers at the Universities of Colorado and California and was associated with the NACA's Ames Aeronautical Laboratory for 3 months.

The Minta Martin Aeronautical Student Fund was established by the late Glenn L. Martin in honor of his mother, who encouraged him to build and fly his own airplane in 1900. Mr. Martin bequested $250,000 to the Fund, doubling the original endowment of $250,000. It is administered by the Institute to encourage aeronautical engineering education. Duplicate awards are sent to the winners' universities.

Ely S. Levinsky



Richard F. Weick



Constantine L. Zakhartchenko *(right)*, an Associate Fellow of the Institute, receives the Navy's Distinguished Civilian Service Award from Assistant Secretary of the Navy for Material Raymond H. Fogler, while Mrs. Zakhartchenko looks on. The Award was made for his work on the Petrel missile.

Zakhartchenko Honored by USN for Work on Petrel Missile

Constantine L. Zakhartchenko, an Associate Fellow of the Institute, has received the Navy's Distinguished Civilian Service Award for his work on the Petrel air-to-surface missile. He was Director of the Engineering Department of the Naval Ordnance Experimental Unit at the Bureau of Standards from 1950 to 1956. He now is a Consulting Engineer.

The citation reads:

"For exceptionally distinguished service to the United States Navy while serving as Director of the Engineering Department, Naval Ordnance Experimental Unit, Washington, D.C., where he made an extraordinary contribution to the Navy Guided Missile Program involving the origination, formulation, and execution of a unique system of technical control of the Petrel Guided Missile.

Mr. Zakhartchenko also holds the Cross of St. George, received in Russia during the Revolution, and a Chinese decoration granted for service to Gen. Chiang Kai-chek.

IAS Secretary Named to AGARD Committee

Robert R. Dexter (F), Secretary of the Institute of the Aeronautical Sciences, has been appointed a member of the Documentation Committee of NATO's Advisory Group for Aeronautical Research and Development.

Mr. Dexter was notified by Theodore von Kármán, Chairman of AGARD, of his appointment.

Stanford Appoints Nicholas J. Hoff Executive Head of Aero. Engineering

Nicholas J. Hoff (F), Professor and Head of the Aeronautical Engineering Department at Polytechnic Institute of Brooklyn, has been appointed Executive Head of the Division of Aeronautical Engineering at Stanford University. Dr. Hoff will go to Stanford September 1.

He is a member of the Editorial Committee of the JOURNAL OF THE AERONAUTICAL SCIENCES, Chairman of the U.S. National Committee on Theoretical and Applied Mechanics, and a member of the Structures Panel of the Advisory Group for Aeronautical Research and Development, NATO.

Dr. Hoff is a Fellow of the Royal Aeronautical Society and delivered its Wilbur Wright Memorial Lecture in 1953. He has been awarded medals for achievement by the Engineering Society of Sweden and the University of Liége in Belgium.

He enrolled at Stanford in 1939 and served as research assistant in the University's Vibration Laboratory while studying for his Ph.D. there. Aeronautical Engineering, formerly in the Department of Mechanical Engineering, will become an autonomous division of the School of Engineering when Dr. Hoff arrives.

Nicholas J. Hoff

Servomechanisms, Inc. Is New IAS Corporate Member

Servomechanisms, Inc., New York manufacturer of high-performance electronic and electromechanical control systems, has joined the Institute as a Corporate Member.

The firm designs, develops, and produces control instrumentation and equipment which falls into the broad scope of servomechanisms. Computers and instrumentation devices are made for military aircraft, missiles, and for industrial applications. Servomechanisms also manufactures an array of precision components.

The company employs what it calls a unique concept in the development of its subsystems and components, resulting in an assortment of standard and semistandard "building block" packages which can be used for many applications.

This "building block" concept is exemplified in many subsystems—one being the Master Data Computer which, on one chassis, provides a single coordinated source for input information required by the various aircraft control and instrumentation systems. It is a central "clearing house" for aerodynamic intelligence.

The firm's Eastern and Western Divisions are in Westbury, L.I., and Hawthorne, Calif. Mechatrol Division is in Westbury and Mechaponents Division in El Segundo, Calif.

Necrology

Raymond M. Ryan

Raymond M. Ryan (M), Commonwealth Aircraft Corporation Resident Representative at North American Aviation, Inc., Los Angeles, died on October 2. He was 30 years old.

Mr. Ryan was a Design Engineer specializing in air frames and engines. He was responsible for all matters relating to the F-86E license agreement his firm held from North American. He had done design work in radio, radar, hydraulic systems, aerodynamics, performance, and stress analysis for Commonwealth, an Australian firm which he joined in 1949.

An officer of the Royal Australian Air Force, Mr. Ryan held successive posts as Officer in Charge of RAAF Radar Research and Development, Radar Central Repair and Testing Section, Chief Technical Officer, Radar Organization, Northern Australia, and Radar Officer. He held this latter post from March to November, 1942, and was responsible for the initial erection and operation of radar warning and interception control stations in Northern Australia.

Mr. Ryan was graduated from the University of Sydney with a B.S. degree in 1946 and with a Bachelor of Aeronautical Engineering degree in 1948. He had been a Student Member of the Royal Aeronautical Society.

(*Continued on page 60*)

Editorial

Harry F. Guggenheim (HF)

His interest in fostering better understanding among nations of the world in all areas has led to a proposal for the establishment of a series of International Congresses in the Aeronautical Sciences. In this project the Institute will play an important part.

PARTICIPANTS IN INTERNATIONAL CONGRESS PLANNING MEETING
New York, January 29–30, 1957

AGARD	Theodore von Kármán	*Chairman*
	Frank Wattendorf	*Director*
Canada	J. J. Green	*Past President, CAI*
England	E. T. Jones	*President, RAeS*
	A. M. Ballantyne	*Secretary, RAeS*
France	Maurice Roy	*Director, ONERA*
Germany	H. Blenk	*President, WGL*
Holland	H. J. van der Maas	*Professor of Aeronautics, Delft*
Spain	A. Perez-Marin	*National Aeronautical Institute*
Switzerland	R. Greinacher	*Sérvice Technique*
Sweden	B. Lundberg	*Director, Aeronautical Research Institute*
United States	M. I. Peale	*President, IAS*
	Harry F. Guggenheim	*Honorary Fellow, IAS*
	H. L. Dryden	*Past Presidents, IAS*
	T. P. Wright	
	C. J. McCarthy	
	L. B. Richardson	
	E. R. Sharp	
	S. P. Johnston	*Staff, IAS*
	R. R. Dexter	
	J. J. Maitan	
	W. A. Shrader	
	E. W. Robischon	

Toward One World in Aeronautics

One of the most important events of the Twenty-Fifth Annual Meeting of the Institute did not appear on the official program. At an informal dinner on Tuesday evening, January 29, in the Hotel Sheraton-Astor, representatives of scientific societies from overseas and a representation of IAS Council and Officers (including five past presidents) considered ways and means of extending collaboration in the aeronautical sciences on a world-wide basis. The discussions of that evening will have far-reaching results.

As most members of the Institute are aware, our activities in international areas have been expanding during the past few years. Not long ago Harry Guggenheim suggested that the time had now come when some positive action might be taken to bring together all the scientific bodies of the aeronautical world for discussions of common problems.

There have been many obvious difficulties. Apart from the political problems, economic considerations have stood in the way. It has been impossible to do any long-range planning without some assurance of continuing financial support. To commit even modest amounts for such purposes has been beyond the capabilities of most of the aeronautical societies of the world. To get around this difficulty, Mr. Guggenheim suggested that there could be no better way to utilize the monies that resulted from the sale of the former Guggenheim Estate at Sands Point (L.I.) to the U.S. Navy (in 1951) than to use them to support periodic congresses in the aeronautical sciences in which all countries that have any contribution to make could participate. He suggested further that during our 1957 Annual Meeting we call together a representative group from overseas to explore what might be done with this idea on a continuing basis. As a result of talks that began on January 29 and went through the several days following, agreement was reached that the formation of a series of International Congresses in the Aeronautical Sciences seems feasible and that operation on a biennial basis is practical.

The objective is to encourage free interchange of information in all areas that have any bearing on the advancement of knowledge in all phases of aeronautics. This would be accomplished by collaboration among the organized aeronautical scientific and engineering societies of the world, or equivalent bodies. Every country in the world that has any organized society dedicated to the advancement of the aeronautical sciences would be invited to participate without regard to immediate military or political interest.

It is proposed that International Congresses in the field of the aeronautical sciences be organized from time to time and also that groups of specialists in various phases of aeronautics meet at an appropriate time in a selected location to discuss particular programs or projects. Every other appropriate means of accomplishing an effective interchange of scientific information should be exploited.

The International Congresses would be held at about 2-year intervals. It is proposed to hold them in the years between the scheduled Anglo-American and Pan European meetings—i.e., in even-numbered years. The selection of the locale and the general subjects to be covered in any particular Congress would be determined by the Council (see below). Programs would be organized by international committees in the various fields of interest (aerodynamics, structures, propulsion, aeroelasticity, aeromedicine, flight-test engineering, etc.).

At each General Assembly, a Council composed of one member from each participating organization would meet to consider questions of policy and to appoint working subcommittees. The most important of these would be the Executive Committee, which might consist of five to seven members of the Council. The membership of this Committee should be rotated, with each member serving 4 to 5 years in a staggered pattern for continuity. The IAS would serve as the general administrative agency and would provide "logistical support" from "The Daniel and Florence Guggenheim Memorial Fund for the Promotion of International Collaboration in the Aeronautical Sciences."

Further, in appreciation of the source of the funds that will make these meetings possible, a suggestion has been made that at each International Congress a "state of art" lecture in some field of the aeronautical sciences be given by an outstanding scientific figure. These would be known as "The Daniel and Florence Guggenheim International Memorial Lectures in the Aeronautical Sciences."

The first Provisional Council for the International Congresses is scheduled to meet in Paris on June 1 to formulate plans for the first meeting at some appropriate date in 1958.

In this program of intensified international collaboration, the Institute will play an important part. Not only will its funds support in a large measure the administrative activities of the organization but its staff will act as a permanent secretariat and will coordinate such matters as selection of technical papers, preparation of programs, provision of translation services, publication of proceedings, etc.

Thanks to our past years of collaboration with The Royal Aeronautical Society, AGARD, and other international groups, we have a certain amount of background in such matters. We can look forward with pride to our participation in this new body on a world-wide scale, and we can proceed to carry out our assigned part with a confidence based upon a considerable amount of prior experience.

S.P.J.

Review of experiments done in the application of boundary-layer control for drag reduction, and discussion of the resulting gain in performance for long-range airplanes.

Progress in Low Drag Boundary-Layer Control

Edgar Schmued*
Northrop Aircraft, Inc.

CONSIDERABLE work has been done in this country and in England on the problem of boundary-layer control as applied to drag reduction, with resulting success such that serious consideration should be given to the application of boundary-layer control to actual airplanes. The experiments carried out have indicated that there is a large payoff in the long-range application. First, let us review the work that has been done so far.

The difference between the laminar and turbulent friction coefficients of a flat plate indicates that considerable drag savings could be achieved on an aerodynamic surface if the range of laminar flow were extended close to the trailing edge of the surface. It has been established that the locus of transition from laminar to turbulent boundary layer is greatly influenced by the pressure gradient of the external flow. A decrease in pressure—that is, an acceleration of the potential flow—has a stabilizing effect on the laminar layer so that transition occurs at a higher Reynolds Number; whereas an increase of pressure—that is, a deceleration of the potential flow—is highly destabilizing. An immediate application of this basic fact may be seen in the NACA series of low drag airfoil sections where the position of the maximum thickness has been shifted backwards so that a larger portion of the airfoil section is exposed to favorable pressure gradients.

A further drag reduction on wings therefore depends on the development of suitable methotls for maintaining laminar flow, even in the presence of adverse pressure gradients in the potential flow in the rear portion of an airfoil. This problem can be solved by boundary-layer suction based on studies by Prandtl in 1904.

The application of boundary-layer control for drag reduction deals with the laminar boundary layer and attempts to delay the transition to turbulent flow. By removing part of the boundary layer nearest to the wall, a new boundary-layer velocity profile develops which is more stable than the original one without suction. Continuous suction from a station not far ahead of the minimum pressure to the trailing edge of the wing increases the stability of the laminar flow to such an extent that even the steep positive pressure gradients in the rear part of the airfoil do not cause premature transition. The basic theoretical work about this type of boundary-layer control was done by Schlichting and his coworkers after 1940. The first detailed experiments were made at Ackeret's Institute in Zurich, Switzerland, principally by Dr. Pfenninger. Dr. Pfenninger used, in his first suction experiments in Switzerland, a wing with a set of carefully designed discrete slots. The sucked air was collected in individual suction chambers underneath the slots inside the wing and removed by a common suction pump. He observed full laminar flow and low drag coefficients at length Reynolds Numbers up to 2.5×10^6.

An Air Force contract with Northrop enabled Dr. Pfenninger to continue his work after he joined Northrop Aircraft, Inc., in 1949 by extending the range of full laminar flow to high Reynolds Numbers. Suction slots were installed in the aft portion of a long 2-in. inside diameter straight tube, and laminar flow was observed in the presence of positive pressure gradients and high length Reynolds Numbers. Later, a two-dimensional straight wing, with suction slots on upper and lower surfaces, was built and tested in 1951 at the NACA TDT tunnel at Langley Field. One hundred per cent laminar flow and low drag coefficients were observed up to 16×10^6 chord Reynolds Numbers. The drag coefficients are shown in Fig. 1. These drag values include the so-called suction drag, which is the equivalent to the power needed to suck the air and accelerate it back to free-stream velocity.

Presented at the IAS Washington, D.C., Section meeting, Jan. 8, 1957.

* Vice-President, Engineering.

These tests indicated the sensitivity of an extended range of thin laminar boundary layer against any type of disturbances. The models had to be polished for reducing surface roughness and waviness, the slot entrances had to be built carefully to avoid steps in the contour, and the tunnel turbulence level had to be low. The reason for the drag rise at the end of the drag curves vs. Reynolds Numbers was that the combined effects of model condition and tunnel turbulence did not permit 100 per cent laminar flow at higher tunnel speeds.

In order to eliminate the effect of tunnel turbulence, boundary-layer suction was carried out in several flight experiments. These were accomplished by Professor Raspet at Mississippi State College on a sailplane and in England and at Northrop Aircraft on glove-like wing sections mounted on a jet airplane.

Raspet used a 4-ft.-wide section of a sailplane wing and perforated the fabric-covered aft portion (beyond the 35 per cent C line) with a needle to produce a porous surface of spanwise rows of narrowly spaced holes. Length Reynolds Numbers between 2 and 4 $\times$ 10^6 were obtained, and laminar flow was observed over the whole wing chord.

The British experiments were performed on a Vampire aircraft to which a suction sleeve had been fitted over part of the upper surface of the wing. Suction was applied through closely spaced rows of perforated strips imbedded in a continuous metal skin. The boundary-layer air was sucked into the suction chambers through holes drilled into this skin. The airplane was flown up to Mach Number 0.70, and full laminar flow and low drag values were measured up to about 29 $\times$ 10^6 chord Reynolds Numbers. These flight tests were performed at the Royal Aircraft

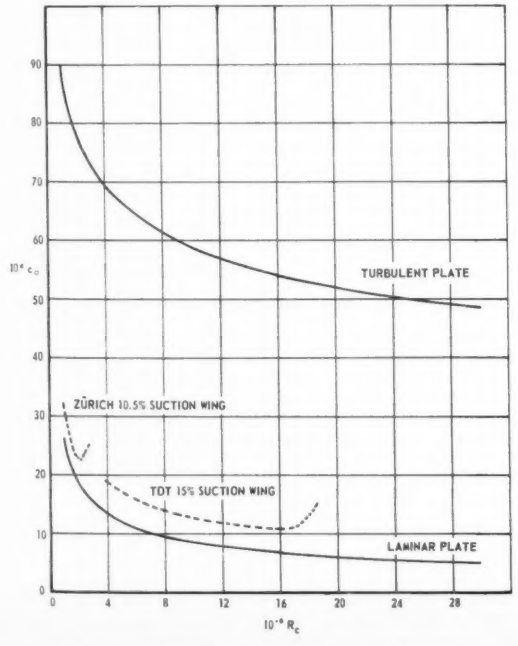


FIG. 1. Drag coefficients vs. Reynolds Number.

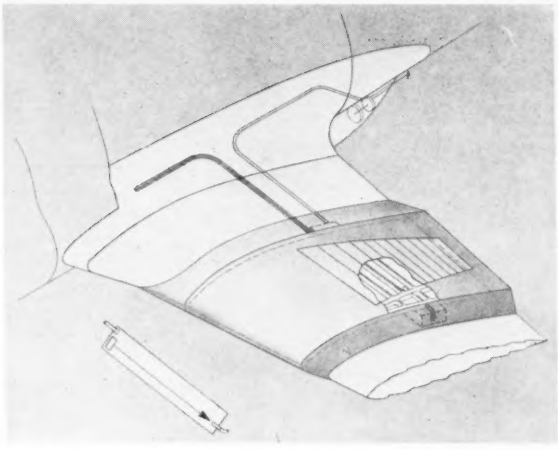


FIG. 2. Boundary-layer control glove installation.

Establishment. A considerable amount of research work on the application of boundary-layer suction to an actual airplane and performance studies on the possible range increase of conventional airplanes have been carried out by Dr. Lachmann at Handley Page, Ltd.

In Dr. Lachmann's studies, suction was applied through porous surfaces, which resembled the theoretical approach of "continuous suction." Although this method theoretically provides a better efficiency, it has the practical disadvantage that a porous surface is rather rough and the insertion of porous strips into the contour usually leads to small steps. The same observations were also made by the NACA in wind-tunnel measurements with porous material, indicating that the resulting drag coefficients were rather high compared to the low values obtained by Dr. Pfenninger with discrete slots.

The flight tests at Northrop Aircraft were performed on an F-94 airplane. The same individual slot and suction chamber method was applied which was so successful in Dr. Pfenninger's previous wind-tunnel experiments. The test glove (see Fig. 2) was equipped with 12 slots aft of the 40 per cent C station, and the sucked air was collected in a suction box inside the airplane wing and removed by a centrifugal blower suction compressor driven by a turbine fed with bleed air from the main engine. Since the surface was kept very clean and the suction slots were built very carefully, it was possible to produce laminar flow to the trailing edge of the glove at low total drag coefficients and high chord Reynolds Numbers. It was particularly important that the laminar flow behaved very reliably in flight and withstood many disturbances easily, such as jet noise, wing vibrations, and atmospheric turbulence; even some surface contamination from insect impingement did not cause turbulent wedges at high flight altitudes.

These results were so promising that intensive studies for a practical application of boundary-layer control on an actual airplane seemed to be justified. First of all, a new type of suction slot had to be developed which kept the wing structurally intact and which could be manufactured easily. Such a practical design was

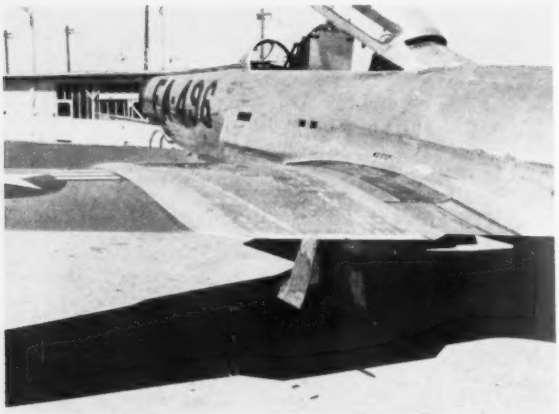


FIG. 3. F-94 airplane with glove installation.

found by bonding a thin skin on a structural inner skin and cutting narrowly spaced slots with a saw. The sucked air went through a set of holes in the inner skin into suction chambers which were built as structural members of the wing. Manufacturing of this suction system proved to be practical. It was flight-tested on the same F-94 airplane and resulted in the same low drag coefficients. Full laminar flow was observed up to the highest Reynolds Numbers which could be flown according to the performance of the airplane. A picture of the F-94 airplane with the installation of many fine slots is shown in Fig. 3. This glove had 69 slots instead of the 12 slots in the first glove. Over 100 flights have been made with full laminar flow using boundary-layer control.

Another design problem deals with the suction compressor which has to suck the boundary-layer air and eject it to the rear. The suction compressor can be driven by a turbine connected mechanically to the main engine through a direct drive. Exhausts of the jet and boundary-layer air are located next to each other. The overall engine efficiency is slightly increased because of the additional air volume ejected. The power needed to drive the turbine was already included in the drag values of the laminar wing. More work should be carried out on the suction compressor problem.

Now let us look at the payoff of low drag boundary-layer control. The gain in performance, using boundary-layer control, is most effective on long-range airplanes such as transports, reconnaissance airplanes, tankers, or bombers. The gain in performance is made by extending the range due to the lower drag of a boundary-layer control airplane over a turbulent airplane. Another way to look at it would be to say that one can meet a required range with a lower weight airplane, using boundary-layer control, than one that has turbulent flow. This results in a reduction in initial investment costs as well as operating costs. Lieutenant General Donald Putt recently told a Congressional committee that successful application of boundary-layer control could reduce the weight of the 400,000-lb. B-52 jet bomber to perhaps 225,000 lbs., effecting very substantial economics and giving the plane much improved range performance.

In order to utilize fully the low drag resulting from boundary-layer control in the design of an airplane, it is also necessary to keep the induced drag low by using wings of high aspect ratios. Furthermore, such airplanes should cruise at high altitudes where the Reynolds Numbers are low because of the sensitivity of the laminar boundary layer to roughness. Detailed weight studies have shown that the additional ducts and the compressor system for the sucked air cause only small weight increases so that the overall gain in performance is overwhelming.

Fig. 4 shows the range performance gain of a boundary-layer control airplane over a turbulent airplane for different take-off gross weights. Both airplanes are based on the same fixed pay load. The boundary-layer control airplane is assumed to have laminar flow on the wing, tail surfaces, and nacelle only. The fuselage is assumed to be turbulent. The tremendous gain in range between the boundary-layer control airplane and the turbulent airplane of the same weight may be noted.

In conclusion, I would like to say that boundary-layer control for low drag appears to many of us as the next aerodynamic breakthrough. Some basic information on maintaining laminar flow on bodies of revolution and swept-wing surfaces have been obtained experimentally. Indications are that boundary-layer suction will be beneficial for long-range cruising at supersonic speeds, as well as subsonic speeds. If the fullest expectations are realized with boundary-layer control, the effect should be a large reduction in the very expensive costs of the weapon systems that are facing us in the near future.

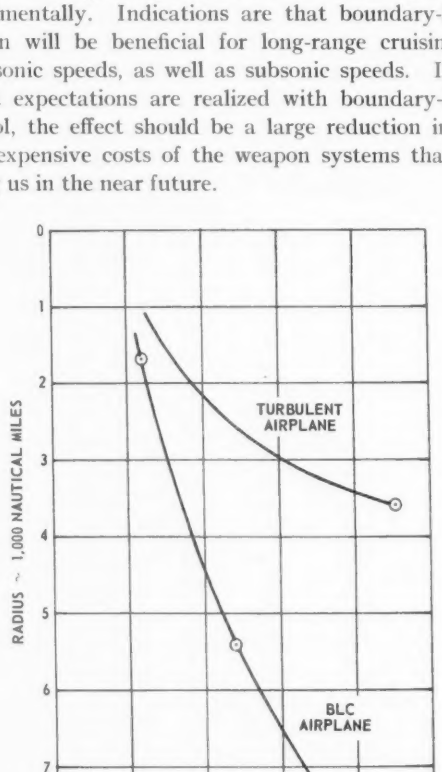


FIG. 4. Range comparison of BLC and turbulent airplane.

A discussion of the need for an instrument making possible the collection of operational time histories of the accelerations, static pressure, total head pressure, and stagnation temperature of high-speed aircraft.

Elevated Temperature Requirements for a New Air-Borne Flight Analyzer

Christian J. Van Der Maas*
The Glenn L. Martin Company

Introduction

In designing for high-speed flight, the air-frame engineer must consider the effects of aerodynamic heating. The resulting elevated structural temperature must be accounted for simultaneously with the exposure to various loadings.

A coupling of temperature and load effects tends to hasten normal attrition of the structure. The degree to which these accelerated changes occur is dependent on the accumulated times of exposure at various levels of load and temperature. This deterioration takes many forms, such as changes in material properties, accumulation of deformation, changes in stress distributions, changes in air loads due to deflection, and fatigue. If future designs are to be successful, the air-frame engineer must be able to predict and allow for these variables during initial design.

Exposure is affected principally by the operational history of the airplane. There is a need then for operational flight records that will permit quantitative evaluation of this exposure. This article establishes the air-frame designer's requirements for exposure data and points out how future analyzers can be adapted to provide these data in proper form.

Since aircraft exposure is characterized by its random and unpredictable nature, the problem becomes a statistical one. The fundamental features of the exposure parameters—load, temperature, and time—must be expressed in terms of statistical averages and probability distributions. These can be obtained through appropriate reduction and statistical evaluation of flight records. In looking forward, if basic laws are established from operational histories of present and past vehicles, a basis for the prediction of exposure can be established for new designs.

A second and equally important feature of the study of load, temperature, and time flight data is proof of initial environmental design assumptions. When the new design enters operational service, exposure data could be gathered and compared with initial assumptions to determine their validity, as well as the rate at which the vehicle uses up its allowable attrition or related life span.

Flight Analyzer Development

One of the oldest flight analyzers was the NACA-developed VG recorder, used primarily to obtain gust data. It scratched the air speed - load factor record on a piece of smoked glass. Because there was no time scale, many records were retraced over the same speed range, almost completely obscuring previous records. Although higher load levels were recognizable, the lower ones usually were subject to doubt. Only extreme values of the load factor and air speed could be read. This instrument would be wholly inadequate for measurement of the high-speed aircraft exposure.

Later, when altitude became an important factor, the NACA developed the VGH recorder, also used mainly in gust studies. For maneuver studies, the Air Force flight analyzer appeared, and the Navy developed the VGTA recorder. These instruments supply continuous trace records of normal load factor, air speed, and altitude with time. For long-range airplanes, however, the record speed is reduced until the time scale becomes undiscernible. Temperature-time history can be computed from the air speed and altitude records but only with the aid of a standard atmosphere. Finally, because the record is of the trace type, data reduction is costly and time consuming.

Recently, the Armed Services and the NACA combined their efforts to establish specifications for a new

* Structural Design Section.

flight analyzer. Its method of recording will be fully compatible with automatic data reduction processes. It will record eight variables, three linear accelerations, three angular accelerations, indicated air speed, and altitude—all as functions of time.

Modifications Recommended for Flight Analyzer

The principal disadvantage of present and proposed flight analyzers is that they do not record stagnation temperature. Stagnation temperature is needed by the air-frame designer because it is independent of airplane design. Being a unique function of ambient temperature and Mach Number, stagnation temperature is an operational variable. It may be calculated roughly from recorded values of pressure altitude and calibrated air speed with the aid of the standard atmosphere. However, it will be shown that, except where large errors are acceptable, in-flight measurement of temperature is required.

There is a further need for simultaneous readings of the variables of temperature and load with time. Although mathematically independent, these variables may be shown to be statistically correlated. To obtain this correlation, simultaneous presentation is necessary. Current flight analyzers usually permit reading of only the extreme values, while correlation between variables is difficult to obtain.

Table 2 and Fig. 2 show how the desired features can be obtained from present instruments with the addition of one channel and the modification of two existing channels. This would make possible the collection of operational time histories on stagnation temperature, ambient temperature, true air speed, Mach Number, and pressure. Approximate altitude to be used as a geometric scalar value would be derived from pressure and ambient temperature, assuming standard atmospheric conditions.

An additional—and unplanned—benefit of this approach is that it also would facilitate statistical studies of the variation of the atmosphere's physical properties with pressure isobars or approximate altitude.

Temperature Recording vs. Computation

A fairly accurate stagnation temperature could be computed if accurate data were available on altitude/ambient temperature probabilities and distributions, assuming standard atmospheric conditions. However, in Fig. 1, curves (d) through (g) show that it usually is impossible to predict the applicable standard atmosphere. The scatter is about 20° to 80°F.

For statistical analysis the stagnation temperature must be used as the temperature variable because it is independent of the airplane design and dependent only on the operational history of the vehicle. However, for

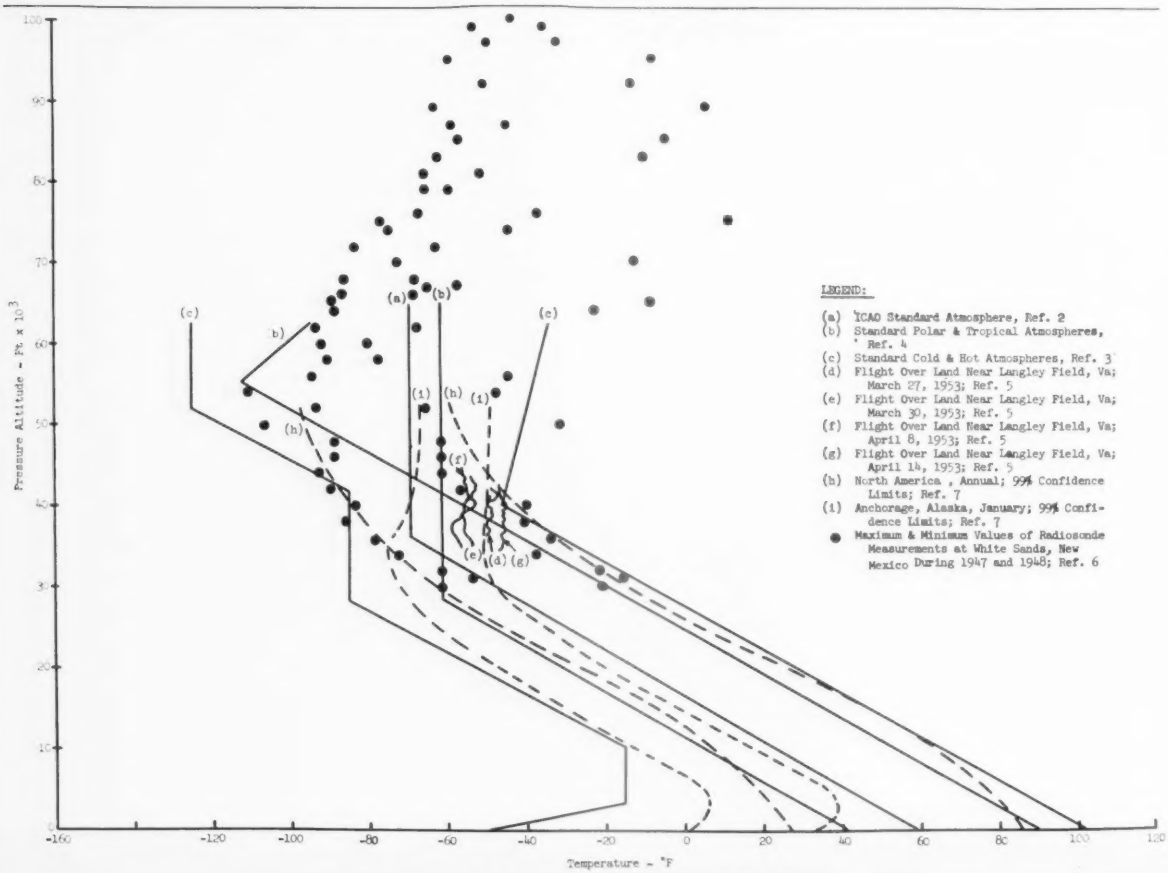

Pressure Altitude - Ft x 10³
Temperature - °F
-160
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
120
LEGEND:
(a) ICAO Standard Atmosphere, Ref. 2
(b) Standard Polar & Tropical Atmospheres, Ref. 4
(c) Standard Cold & Hot Atmospheres, Ref. 3
(d) Flight Over Land Near Langley Field, Va; March 27, 1953; Ref. 5
(e) Flight Over Land Near Langley Field, Va; March 30, 1953; Ref. 5
(f) Flight Over Land Near Langley Field, Va; April 8, 1953; Ref. 5
(g) Flight Over Land Near Langley Field, Va; April 14, 1953; Ref. 5
(h) North America , Annual; 99% Confidence Limits; Ref. 7
(i) Anchorage, Alaska, January; 99% Confidence Limits; Ref. 7
Maximum & Minimum Values of Radiosonde Measurements at White Sands, New Mexico During 1947 and 1948; Ref. 6

Fig. 1. Variation of the ambient temperature with altitude.

TABLE 1
Effects of Scatter of Ambient Temperature About Standard Conditions
(36,000 to 100,000 Ft. Altitude, $T_a = -69.7°F.$)

Mach Number	T_{BL}/T_a	T_{BL}(°F.)	Deviation of Boundary-Layer Temperature, T_{BL}, °F., for Given Variations of ΔT_a					
			*ΔT_a = 10°F.	20°F.	30°F.	40°F.	60°F.	80°F.
2	1.72	211.7	17.2	34.4	51.6	68.8	103.2	137.6
3	2.62	563.1	26.2	52.4	78.6	104.6	157.2	209.6
4	3.88	1,055.1	38.8	77.6	116.4	155.2	232.8	310.4

* Refer to Fig. 1.

purposes of comparison, the boundary-layer temperature for a given vehicle gives a closer approximation of the actual detail design temperature environment of the airplane. Assuming that 90 per cent of the heat is recovered on a certain aircraft and that the ratio of specific heat for dry air is $\gamma = 1.40$, then the boundary-layer temperature is given by $T_{BL} = T_a(1 + 0.18\ M^2)$.

Therefore, depending upon the Mach Number, the deviation of the boundary-layer temperature, ΔT_{BL}, is obtained by multiplying the deviation of the ambient temperature, ΔT_a, by a factor $(1 + 0.18\ M^2)$ as indicated in Table 1.

For example, if the ambient temperature varies $T_a = \pm 20°F.$ about its standard value in the stratosphere, then the boundary-layer temperature for Mach 3 flight will vary $\pm 52.4°F.$—or from 510.7°F. to 615.5°F.

A study of Fig. 1 indicates that $\pm 20°F.$ approximates normal expected scatter for the ambient temperature. Since Mach 3 flight in the stratosphere is fully expected in the future, it appears that boundary-layer temperatures varying from 511° to 616° do not represent exceptional conditions. In fact, variations often will be much greater, as a comparison of Fig. 1 and Table 1 indicates.

From this it may be concluded that:

(1) The scatter of the ambient temperature about standard conditions varies from $\pm 20°F.$ to extreme values approximating $\pm 80°F.$

(2) Corresponding scatter of the boundary-layer temperature for Mach Numbers 2 to 4 is obtained by multiplying with a factor of 1.72 to 3.88 (assuming 0.90 recovery factor).

(3) Variation of the actual boundary-layer temperature about that based on standard conditions of approximately $\pm 50°$ to $\pm 100°F.$ can be expected with relatively high frequency.

These conclusions do not take into consideration that, at constant pressure altitude, variations of the ambient temperature induce changes in the air density and consequently in Mach Number. This phenomenon tends to increase the scatter of the boundary-layer temperature even more. Thus it appears that recording the stagnation temperature in flight is warranted.

Alternative Approach

If the stagnation temperature is recorded in flight, then the flight record automatically integrates the variation of ambient temperature due to altitude, operational theater, day of the year, and time of day. In other words, all operational and atmospheric variations are mechanically integrated in the stagnation temperature flight record. However, it will be some time before a statistically adequate number of flight records has been accumulated. Therefore, an alternative approach is desired for interim use.

One such approach is to determine the statistical variation of ambient temperature with altitude from radiosonde observations. Enough data have been accumulated over the years to ensure adequate statistical sampling. For the reasons that caused various standard atmospheres to be adopted, these ambient temperature distributions must be determined for various latitude bands such as polar, median, and tropical.

With such basic ambient temperature distributions established, it would then become necessary either to reconstruct or predict the distribution of operational theaters or latitude bands. The necessary information can be obtained only from a study of log books and operational records. Unfortunately, the form in which these records are kept wou'd make a statistical study very costly and time consuming. Therefore, it appears that the weighting factors or the combination of various ambient temperature distributions must be obtained by rational estimation.

Temperature as a Variable

Although the boundary-layer temperature ultimately must be known for elevated temperature design, it is not a suitable parameter for the description of the operational time history independent of the airplane design. It varies from one airplane to another and over the surface of the same airplane.

With ambient temperature known, boundary-layer temperature could be computed with the expression

$$T_{BL} = T_a\{1 + [(\gamma - 1)/2]RM^2\}$$

where

T_{BL} = boundary-layer temperature, °R.
T_a = ambient temperature, °R.
γ = ratio of specific heat (experimentally determined)
R = recovery factor

However, at present we have no way of measuring ambient temperature at supersonic speeds. In addi-

tion, the recovery factor depends on conditions of laminar and turbulent flow and, therefore, varies over the airplane surface, as well as from design to design.

At this time, only stagnation temperature lends itself to measurement. As a unique function of the true air speed and ambient temperature, stagnation temperature is independent of airplane design and may be regarded as a true environmental temperature parameter.

It is defined by the expression

$$T_{ST} = T_a \{1 + [(\gamma - 1)/2]M^2\}$$

where T_{ST} = stagnation temperature, °R.

With stagnation temperature and Mach Number obtained simultaneously from flight records, the above expression may be used to compute ambient temperature which, in turn, defines the speed of sound. Then true air speed can be computed analytically from the recorded data without reference to a standard atmosphere.

Since the stagnation temperature expression requires information on the local Mach Number, the temperature measuring device ideally would be part of the pitot-static tube. Otherwise, the transducer must be located so that the aerodynamic conditions at the pitot-static tube and the transducer are most nearly the same. Provision also must be made to allow for changes in attitude with relation to the air stream to avoid recording errors.

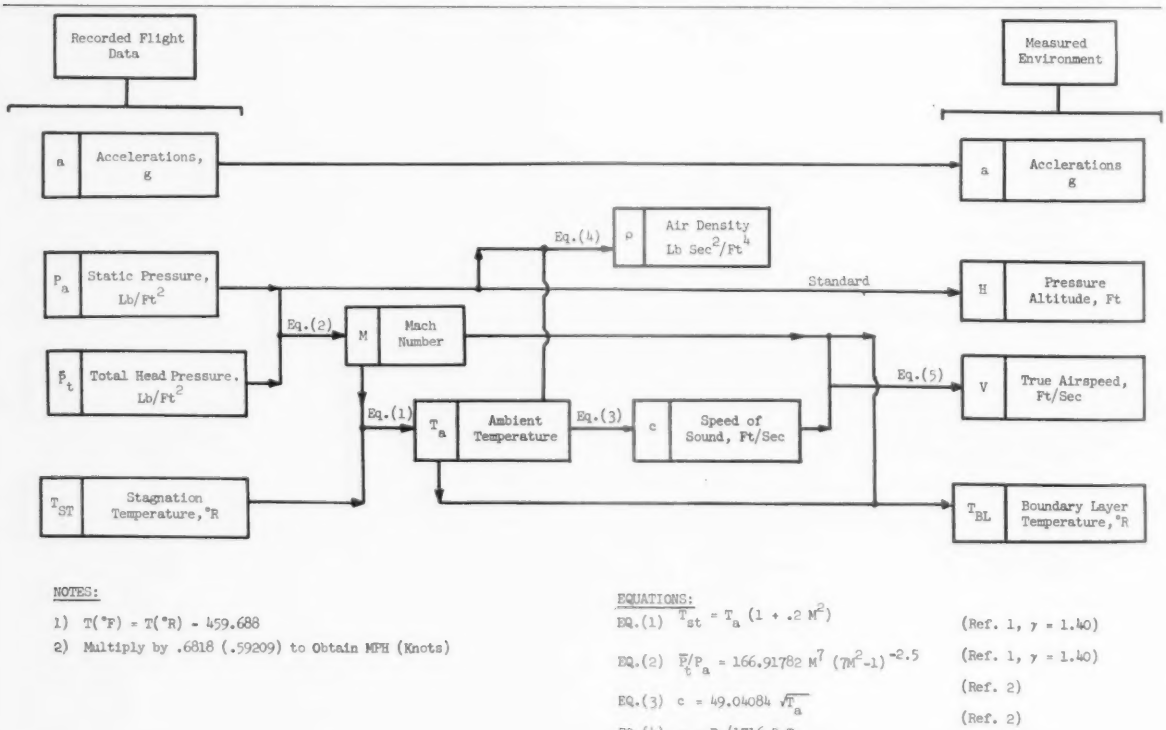
TABLE 2
Flight Analyzer Criteria

Recorded parameters	Parameters that can be computed directly from record (instantaneous values)
Present (including services-sponsored)	
Acceleration*	Mach Number
Indicated air speed	(Other parameters can be computed only with the aid of standard atmosphere)
Pressure altitude	
Required	
Acceleration*	Pressure altitude (standard)
	True air speed
Static pressure	Mach Number
	Ambient temperature
Total head pressure	Boundary-layer temperature
	Speed of sound
Stagnation temperature	Air density
Alternative Requirement	
Acceleration*	Pressure altitude (standard)
	True air speed
Static pressure	Ambient temperature
	Boundary-layer temperature
Mach Number	Speed of sound
	Air density
Stagnation temperature	

* This includes the linear and angular accelerations required to define properly the airplane load history.

MACH NUMBER

Whether or not stagnation temperature is recorded, Mach Number must be known for environmental studies. Since it is a unique function of the ratio of the total head pressure to static pressure, Mach Number can be determined analytically from recorded values of the calibrated air speed and pressure altitude.



NOTES:

1) T(°F) = T(°R) - 459.688
2) Multiply by .6818 (.59209) to Obtain MPH (Knots)

EQUATIONS:

EQ.(1) $T_{st} = T_a (1 + .2 M^2)$ (Ref. 1, γ = 1.40)

EQ.(2) $P_t/P_a = 166.91782\, M^7 (7M^2 - 1)^{-2.5}$ (Ref. 1, γ = 1.40)

EQ.(3) $c = 49.04084 \sqrt{T_a}$ (Ref. 2)

EQ.(4) $\rho = P_a/1716.5\, T_a$ (Ref. 2)

EQ.(5) $V = Mc$ (Ref. 1)

FIG. 2. Determination of aerodynamic parameters from recorded data.

However, direct recording of the total head pressure and the static pressure has two advantages—it simplifies the computations for obtaining Mach Number and reduces the weight of the flight analyzer by omitting the air-speed indicator and altimeter.

Operating Range

A comprehensive picture of aircraft exposure would include records of load time history through the complete airplane life—including take-off, landing, and ground-handling loads. Measurement of these data by the flight analyzer furnishes only the response to landing and ground-handling loads—not the loads themselves. But if, as expected, the power spectral method of analysis is perfected for application to landing conditions, the forcing function can be determined from recorded data.

Therefore, it is recommended that the automatic switch on the flight analyzer be activated when the engines start—not at an arbitrary minimum air speed. This operating procedure, in combination with the recommendations regarding the parameters to be measured, would furnish flight record data from which the total high-speed aircraft exposure could be derived.

Frequency Response

The high-speed aircraft exposure includes the two load producing phenomena—gust and maneuver. Of these, gust loads have been investigated most thoroughly. However, the available data are still of limited scope, especially at high altitude. Recently, maneuvers have been studied on a statistical basis. These data are even more limited than the high altitude gust data. Therefore, it is felt that the flight analyzer should record the response to both gust and maneuver.

In the past, flight records were required for the study of the fatigue exposure and needed to indicate only extreme values of load. In the realm of aerodynamic heating, however, the operational history in terms of time at load must be known. This requires the recording of several data points during any one load cycle. This in turn means that the flat response or sampling rate of the flight analyzer must be several times greater than the maximum gust frequency anticipated, the latter being an approximate function of the maximum air speed that can be recorded. Preliminary studies indicate that a flat response or sampling rate from 0 to 25 or 30 cps will be adequate.

In spite of the fact that the gust and maneuver load histories are scrambled on the flight record, a separate analysis of the gust and maneuver phenomena is still possible since the record can be unscrambled in a manner similar to that used at present with the trace type record.[8] Depending on the type of recording system used, the maneuver load history can be obtained by the use of a band pass filter or by reduction of the sampling rate. In turn, the gust load history can be determined by canceling out the previously determined maneuver load history from the total load history. This unscrambling of the flight record can be performed on the ground during the data reduction phase and, therefore, need not add to the weight of the air-borne instrument.

Conclusions

Designers of high-speed aircraft need an efficient way of analyzing, predicting, and verifying the load, temperature, and time dependent aircraft exposure. In making their predictions, they will require large samples of flight record data collected during the operational life spans of existing and past aircraft. The job of verifying the initial environmental design assumptions will make further demands for flight data when the new design becomes operational. A flight analyzer capable of obtaining such data in proper form would incorporate these features:

(1) Continuous and simultaneous time histories of the accelerations, static pressure, total head pressure, and stagnation temperature.

(2) Uninterrupted operation during the complete ground-air-ground cycle.

(3) A flat response or sampling rate of from 0 to 25 or 30 cps, depending on the maximum air speed that can be recorded.

A universal instrument of this kind will be a valuable data source for the study of all types of parameter, such as combined gust and maneuver, discrete maneuvers, extreme values, atmospheric studies, and stability studies. There is a growing need for information concerning such parameters. A flight analyzer incorporating the features proposed herein would have a long-term value to the engineer and scientist.

References

[1] Shapiro, Ascher H., *The Dynamics and Thermodynamics of Compressible Fluid Flow*, Vols. I and II; The Ronald Press Company, New York, 1953.

[2] *Manual of the ICAO Standard Atmosphere-Calculations by the NACA*, NACA TN 3182, May, 1954.

[3] *Atmosphere Properties—Extreme Cold and Hot; Standard for Aeronautical Design*, ANA Bulletin No. 421, September 24, 1953.

[4] *Atmospheric Properties—Polar and Tropical Atmospheres; Standard for Aeronautical Design*, ANA Bulletin No. 432, October 28, 1954.

[5] Lina, Lindsay J., *Measurements of Pressure and Temperature for Appraisal of the Temperature Method of Airspeed Calibration in the Lower Atmosphere*, NACA TN 3075, March, 1954.

[6] *A Study of the Atmosphere Between 30,000 Feet and 100,000 Feet (Preliminary Report)*, NA 50-1C517, Aerology, Flight Service Section, Chief of Naval Operations, Washington, D.C., September, 1948.

[7] *Atmospheric Temperature Variation with Altitude*, General Electric Report No. R51 A 0522, Project Hermes, Special Project Engineering Division, Aeronautics and Ordnance Systems Engineering Division, Apparatus Department, Schenectady, N.Y., July, 1951.

[8] Coleman, Thomas L., and Copp, Martin R., *Maneuver Accelerations Experienced by Five Types of Commercial Transport Airplanes During Routing Operations*, NACA TN 3086, April, 1954.

Seminar delegates observe air-sea rescue demonstrations at Palm Beach Shores.

Air Safety Problems

A Round-Up of the 8th Annual International Seminar of the Flight Safety Foundation

Welman A. Shrader*
and
R. C. McGuire**

SHOULD AUDITORY SIGNALS replace optical warning devices in the cockpit? What are the ground hazards of high-performance radar? Where should exit doors be placed in swept-wing transports? Wheels up or down in ditching at sea? And what about traffic control, mid-air collisions, rearward facing seats, high-altitude glare, and space myopia—not to mention sharks?

These, and myriads of other questions, were discussed in the latest, largest, and most successful Seminar yet put on by the Flight Safety Foundation. The field of subjects covered was matched only by the varied interests of the participants. Over 250 representatives of industry and government from eight countries attended this year's meeting, which was held in cooperation with the Military Air Transport Service at Palm Beach, Fla., December 3–7, 1956.

The purpose of FSF Seminars is to discuss safety problems in an atmosphere of calm objectivity, away from the daily press of critical decision-making; to bring together professional people with kindred interests who might not otherwise have a chance to exchange ideas; and to afford an opportunity to gain perspective —wherein the design engineer obtains an appreciation of operating problems and operators gain a better understanding of problems confronting the engineer. Emphasis is placed on an exchange of viewpoints so that participants gain a better appreciation of the problems that face the other man.

The success of this formula (plus "Jerry" Lederer's happy faculty for choosing "calm atmosphere" locales) has been proved by the steady growth of these FSF seminars since their inception. The largest on record, the 1956 attendance represents a 178 per cent increase over the 1955 meeting, which was held in Taxco, Mexico (reported in the February, 1956, issue of the REVIEW).

*Director of Publications, IAS.
**Eastern Air Lines, Inc.

Thirty-one papers and several demonstrations were given during this year's 5-day meeting. Following are a few brief notes on these presentations.

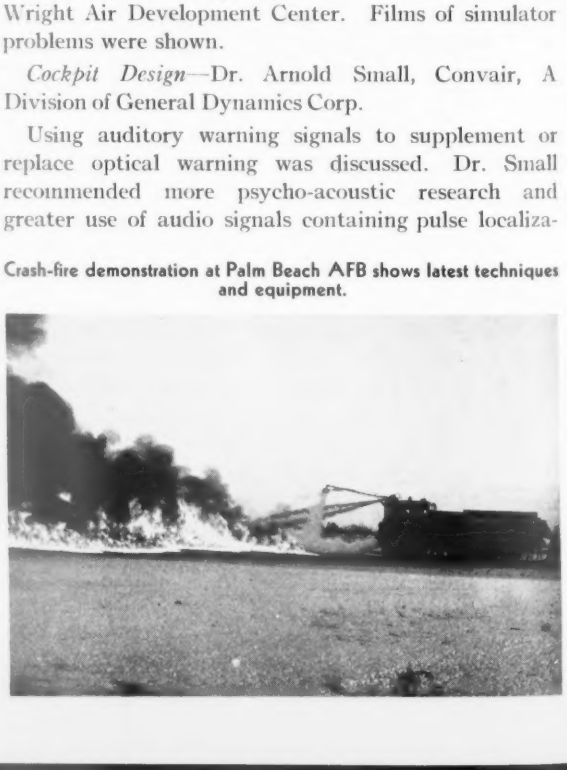
Human Engineering for Semiautomatic Ground Control—Dr. Jerry S. Kidd, Ohio State Research Foundation.

The Aviation Psychology Laboratory of Ohio State became interested in air traffic control problems 10 years ago. It has developed an ATC simulator device which is used to "provide a measure of human capacity and reliability relative to various ATC systems." Several variables are studied—display, traffic, procedures, etc. Existing and new systems are checked. Ohio State is using experienced controllers from Wright Air Development Center. Films of simulator problems were shown.

Cockpit Design—Dr. Arnold Small, Convair, A Division of General Dynamics Corp.

Using auditory warning signals to supplement or replace optical warning was discussed. Dr. Small recommended more psycho-acoustic research and greater use of audio signals containing pulse localiza-

Crash-fire demonstration at Palm Beach AFB shows latest techniques and equipment.



tion, pitch, and discord. The optimum use of such devices may require audio training.

Describing Man for Design Development—Dr. Barry King, CAA.

Dr. King emphasized the need for more comprehensive description of research and development results to enhance use in design. Data can be overpresented; the type of presentation should be evaluated before the lab work is begun. Typical examples of good presentation were cited.

Special Problems in Analysis of Air-Crew Jobs—Julien Christensen, WADC.

WADC analyzes crew jobs to adapt the job to the man and evaluate the man for the job. They use movies, tape recorders, behavior records, and time studies. The relationships measured between Air Speed, Directional Gyro, and Gyro Horizon in movie analysis of pilot's eye effort during GCA approach led to the "sacred six" instrument arrangement

AS–DG–GH
ALT–T/B–R/C

Poor human engineering design can promote fatigue, error, and injury.

Psychological Aspects of the Jet Age—Dr. Neil D. Warren, University of Southern California.

Dr. Warren discussed Air Force experience with multiengined jet bombers from the psychologist's standpoint. He emphasized hazards of high-altitude glare and space myopia, the military experience with fatigue due to tension, and the limited time for action during emergencies. Discussion centered on the similarities and differences in the commercial picture as compared with military experience.

Rapid Decompression in USAF Large Cabin Aircraft—Dr. A. W. Hetherington, ARDC.

Air Force record of rapid decompression incidents for 1951–1955 was described. Based on military experience, recommendations to minimize effects in commercial operations were given: passengers near windows should wear seat belts, loose items should be stowed to reduce missile effect, and one member of the crew should wear an oxygen mask at all times. Lessons learned for future fighter design were also discussed.

Notes on Tire Runway Friction—Melvin N. Gough, NACA.

The speaker discussed the investigation being made by NACA to define maximum friction coefficients between an aircraft tire and the ground under various conditions. Test results disclosed that a high-velocity jet of water, directed at the contact point of tire and ground, can cause a 100 per cent slip of a rolling wheel. This phenomenon appears to indicate that braking may be impossible during a very high speed landing on a wet runway with a given tire footprint area and inflation.

Precision Approach Radar—Col. Willis Beightol, MATS.

Colonel Beightol gave a short presentation on the ambiguities of PAR as a factor of aircraft size. He pointed out the effects of propeller versus landing-gear reflection on aircraft position on scope—approximately 16 ft. of elevation on a C-124.

Jerome Lederer *(right)*, Managing Director of FSF, confers with Col. George W. Peterson, Commanding General of Palm Beach AFB, while Mrs. Lederer, Miss Gloria Heath, Executive Assistant to the FSF Director, and Miss Anita Glazer hold a conference of their own.

Technical Development and Evaluation Center Activities—Alan Morse, CAA.

The Center is concentrating on solution of the fire problem and the in-flight traffic collision problem. Films showed typical nacelle fire tests of the B36 and the S55, crash tests of successful crashproof bladder-type fuel cells, birdproof windshield air gun, bird ingestion in the Allison D-13 engine, and pilot action on a test collision course with DC-3 high-intensity exterior lights. Eighty-five experienced air-line pilots were tested on the collision course. Maximum limit of alertness was 3–4 miles. The B-707 nacelle will be tested for crash-fire inerting and fire extinguishing shortly.

Potential Collisions in Transportation—Howard K. Morgan, Bendix Aviation Corp.

The speaker defined the facets of collision prevention in terms of (a) the collision course, (b) closing motion, and (c) collision warning. This was discussed in terms

Coffee-breaks between technical sessions give occasional breathers at the Colonnades Hotel.

of ground transport, railways, marine navigation, and aircraft. Aircraft required more care because of the three-dimension problem. Warning systems were defined in two classifications—namely, cooperative and noncooperative types.

Proximity Warning Indicator System—George R. Schneider, Collins Radio Co.

The history of industry interest in proximity warning was described, leading to the Radio Technical Commission for Aeronautics SC74 committee specifications completed in June, 1956. The Collins device for Phase I of the anticollision development program was presented. Phase II equipment is to have an extended range and provide automatic evasion. Wright Air Development Center is working on a cooperative type of collision warning system for the higher speed ranges of military aircraft.

Go Right or No Go Concept—Col. James F. Wells, Aviation Safety Division, U.S. Army.

The speaker quoted Murphy's law, "If a part can be installed incorrectly, someone will install it that way sooner or later." He cited several examples of incorrect design and urged the attendees to stress design criteria which would make it impossible for equipment to be misinstalled.

Directional Lighting of Black Surface Highway and Runway Pavement—Edward R. Dye, Cornell Aeronautical Lab., Inc.

The speaker described the development of a reflective paint which has a highway covering power of 200 to 400 sq. yards per gal. Slides were shown to illustrate the difference between coated and uncoated black top pavement. The material is reported to be durable.

The speaker also described the development of an antiskid tire which possesses good friction coefficient on ice. A case-hardened leaf spring is molded into the cleat of a snow tread tire so that the edges of the spring bite into the ice when the cleat is compressed. This design has an average endurance of 800 miles on automobiles.

Convair Safety Program—Wm. F. Funk, Convair, Fort Worth, A Division of General Dynamics Corp.

Mr. Funk stated that the program was conceived to design accidents out of the aircraft during the paper stage by design analysis and laboratory work. For example, the laboratory is presently engaged in establishing reach and strength criteria in relation to aircraft maintenance.

It was also reported that the safety group is included in the service department in order better to coordinate safety with maintenance. The speaker encouraged further emphasis on human engineering and observed that the work of the safety engineer will be evaluated by management in terms of the performance of the airplane.

Vertebral Fractures in Aircraft Crashes—A. Benjamin Sorin, Navy BuAer.

This paper discussed the use and development of an energy absorption system that could be applied to ejection seats and shoulder harness installations. The system involved the use of an energy absorbing seat cushion and a stainless steel strap which was dimensioned to permit an elongation of 50 per cent at about a 25*g* load.

The development was instigated by a study of frequent vertebral fractures which occurred to pilots during nose gear failures on Navy airplanes. Motion-picture films illustrating the action of dummy pilots in crashing airplanes and ejection seats were shown.

Design for Evacuation—Otto E. Kirchner, Boeing Airplane Co.

Mr. Kirchner stated that current commercial evacuation specifications originally outlined about 5 years ago will require reappraisal for swept-wing transports. This is because current procedures make extensive use of rear cabin exits in order to deplane the passengers as far as possible from fuel-fire source. It is well known that the NACA crash-fire tests established a survival time of 90 sec. Inasmuch as swept-wings tend to envelop the aft end of the airplane, new evacuation procedures requiring greater use of the front end of the airplane may be necessary.

Mr. Kirchner pointed out that SAE Committee S-9 was working to standardize the operation of doors, emergency exits, and seat belts in order to enhance safety and facilitate evacuation.

Approach Lighting—Col. Willis Beightol, MATS; and Lt. Col. Howard J. Fry, SAC.

The need for a good standard all-weather system of approach lighting has been recognized for several years. Recent Air Force tests have shown that a system using centerline high-intensity lights is most acceptable. The basic requirements for a good system are standardization of length of light pattern, centerline lights leading to the threshold, color and configuration of lights to avoid confusion, lateral perceptual guidance as well as directional guidance lights, control of bar lights with reference to intensity, and sequenced flashing condenser discharge lights.

For better runway guidance and better visibility aids to glare and landing, the principles of narrow gage lighting will be tested. Some work has been done by the British with flood-lit runways.

Training Pays Off—Capt. Richard Ogg, Pan American World Airways, Inc.; Comdr. William Earle, U.S. Coast Guard; Capt. A. E. Harned, U.S. Coast Guard.

This discussion pertained to the ditching of the Pan American Airways Stratocruiser in the Pacific on October 16, 1956.

Captain Harned described its success in terms of the application of emergency overwater procedures, as publicized and practiced by the U.S. Coast Guard and Pan American Airways' participation in the U.S. Coast Guard air-line indoctrination courses in San Francisco.

Commander Earle described the responsibilities of the U.S.C.G. cutter "Pontchartrain" with regard to weather reporting and air-sea rescue procedure.

Captain Ogg, pilot of the Stratocruiser, described the experience in detail and attributed their success to the air-line and Coast Guard training received. All

24 passengers were saved. Captain Ogg paid high tribute to the conduct of and cooperation by the passengers.

Chemical Materials for Shark Repellent—Alvin L. Allyn, Shark Chaser Chemicals Co.

The Shark Chaser Chemicals Company has studied chemical repellents for about $4^1/_2$ years. There is a definite need for this material in the fishing industry. There is a shark problem in salt and fresh water. The repellent is comprised of 20 per cent copper acetate salt and 80 per cent dye and is retained in cake form by a wax binder. The standard Navy packet weighs 8 oz. When immersed in sea water, a 12-ft. circle, 4 ft. deep, of repellent solution is generated within 60 sec. after immersion. Based on tests with trash fish, the chemical salt is 78 per cent effective, the dye is 97 per cent effective. The repellent affects the sight and scent of the shark. The repellent has no toxic effect on humans and does not repel porpoises.

Crash Injury Research—A. Howard Hasbrook, Aviation Crash Injury Research.

The speaker stated that accident statistics comprise only part of an investigation and that all facts must be analyzed before safe design rules can be evolved. Statistical data must be used with caution. The speaker emphasized these points by presenting statistics on six different accidents involving head injuries. These data were then related to delethalization requirements for seats.

Forward vs. Rear-Facing Seats—Wing Comdr. E. B. Harvey, British Joint Services Mission.

The speaker discussed British accident experience in terms of seat failures and showed several slides in support of aft-facing seating. From the standpoint of passenger preference, he stated that, on a recent commercial flight in this country, a random inquiry showed 92 per cent of the passengers aboard did not care whether the seats were forward or aft facing.

British military transports are designed with 25*g* aft-facing seats and 25*g* floors.

Passenger Crash Protection Device—Assen Jordanoff, Micro Moisture Controls, Inc.

The speaker presented a large L-shaped pneumatic bladder cell which, he claimed, could be inflated by a passenger immediately before a crash and thus provide a cushion between himself and the next forward-facing seat.

Hazards Encountered in the USAF in Transitioning From Conventional to Jet Aircraft—Col. H. G. Moseley, USAF Directorate of Flight Safety Research.

Colonel Moseley stated that Air Force records show that the transition accident frequency is high when pilots change from reciprocating-engine bombers to jet bombers. Major causes involved mishandling of controls; improper execution of, or inadequate, emergency procedures; or misjudgment of distance. Emergency procedures must be executed quickly and correctly because there is less time for error. Distance judgment must be precise because closing and sinking speeds are greater.

The two principals in the PAA Stratocruiser ditching in the Pacific meet again on the sands of Palm Beach, Skipper of the Coast Guard rescue cutter "Pontchartrain," Comdr. W. K. Earle (*left*), and PAA Capt. Richard Ogg.

Discussion brought out the difference in characteristics of commercial jet transports which suggested commercial experience need not follow the military experience.

Earlier in the program, Colonel Moseley presented a discussion of the "Lessons Learned From the Recent MATS C-118 Accident."

Some Suggestions for a Safe Jet Air Liner Re-Equipment and Operations Program—Alan B. Hunter, British Aviation Insurance Company, Ltd.

Mr. Hunter described his interest in the meeting in terms of the insurance theme and made many recommendations. These recommendations included the following:

(a) Avoid too much automation.

(b) Use more intersystem failure analysis.

(c) Design the airplane to be within the capabilities of the pilot.

(d) Military experience should not be compared to commercial experience.

(e) Air-line engineers should appraise designs on the drawing board.

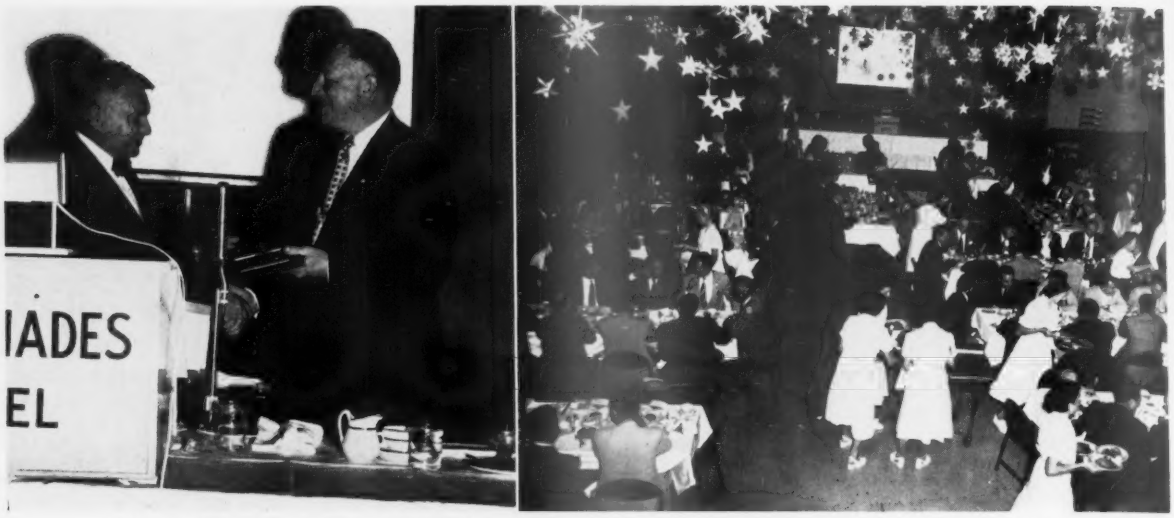
(f) Pilots should recognize the proximity of cruise to maximum speed.

(g) Problems of foreign material ingestion in engines require cleaner runways.

(h) Kerosene fuel appears to be more desirable because it is harder to ignite.

Getting Human Engineering Data Into Practice—William Steiglitz, Republic Aviation Corp.

The speaker stated that industry was slow to use human engineering data in design because it is a rela-



"Jerry" Lederer presents one of the FSF Awards to William Littlewood at the Award Dinner, pictured here at the Colonnades Hotel.

tively new science and consequently stimulates resistance to new ideas. He stated that colleges will not include safety engineering training in their curricula unless industry requests it. The human engineering science must be sold to a greater degree.

In commenting on this paper, Julien Christensen of the WADC stated that the Aero Medical Lab. will issue a human engineering design guide in the near future. A Human Factors Engineering Society is in the process of formation.

Aviation Jet Fuels—Aubrey Keif, The Texas Company.

Mr. Keif stated that the Aviation Technical Service Committee of the Aviation Petroleum Institute has been working for some time in order to resolve jet fuel standards and handling problems. He pointed out that the industry must decide on the use of either JP4 or kerosene-type fuel as soon as possible, but that he expected the choice to be resolved in early 1957.

Mr. Keif then compared the properties of kerosene vs. JP4 and discussed the problems of converting facilities from aviation gas to turbine fuels; he also covered the development of new facilities such as the hydrant system. He stated that fuel trucks should be eliminated, if possible, for safety, space, and accident prevention reasons. He favored under-wing fueling at high rates based on successful experience. He also stated that safe handling of fuel requires good airport system maintenance.

*Take-Off Meter**—Melvin N. Gough, Head Flight Research, NACA, Langley.

Use of air-speed pressure measurement vs. acceleration measurement during take-off was described, and a plea was made for properly combined instrumentation to supply the pilot useful and safe take-off acceleration data. Mr. Gough urged that a small retractable water-ski be added to all transport fuselages to permit reasonably safe ditching.

* Described in NACA TN 3252.

Ground Hazards of High-Performance Radar—Dr. Charles Simon, Hughes Aircraft Co.

The body absorbs 30–40 per cent of heat from 3–10 cm. radar emission. Research indicates that long-time exposure to high powers, unprotected, may be harmful to humans. The speaker suggested that radar maintenance personnel wear a neon gas tube measuring device which will give visual warning of microwave emission of sufficient power to be a potential hazard.

Demonstrations

An air-sea rescue was demonstrated by aircraft and personnel from MATS. Parachutes and life-raft drops were made about 1/2 mile off shore. Equipment for rescue was exhibited.

During a tour of the Palm Beach AFB, Mr. Johnson of U.S. Weather Bureau Project Hurricane located at the base described their work of collecting data on creation, construction, movements, and dissipation of hurricanes. The MATS Flight Simulator School which has two C-118 (DC-6), two C-124, and one C-97 Curtiss-Wright Dehmel simulators in full scheduled operation was visited. All pilots arriving for transition training are given 24 hours on simulators before actual aircraft flight. The effectiveness of a fire fighting unit was demonstrated by the Base Fire Rescue Crew in a mock rescue of a dummy pilot from a burning fuselage surrounded by a 40-ft. puddle of burning fuel. Foam and CO_2 were used to extinguish the blaze.

Life rafts and vests were demonstrated in the hotel pool by Air Cruisers, Walter Kidde, General Textile Mills, and the Patten Company. The Walter Kidde ejection pump device inflated a 20-man raft in 8 sec. as compared to a normal CO_2 inflation time of 38 sec.

Flight Safety Foundation Awards

The annual Award Dinner was held on the evening of December 5 at the Colonnades Hotel, headquarters of

(*Continued on page 56*)

George E. Cooper*
Ames Aeronautical Laboratory, NACA

Understanding and Interpreting Pilot Opinion

An outline of various approaches that have been taken in an attempt to assure the validity and consistency of pilot opinions in flying qualities work. It is suggested that the most important factor involved lies in the formulation of the question to be asked the pilot.

Introduction

It is a recognized fact that pilot opinion is one of the most significant factors in determining important design decisions on our new aircraft. The present flying qualities requirements contain several instances in which the acceptability of a given characteristic is not based on any quantitatively measurable number but rests solely on "pilot opinion." Pitch-up, roll-off, ease of handling in a tracking task, buffet intensity, and magnitude of stall warning are all characteristics that have as yet defied reduction to a measurable criterion and still must be judged by pilot opinion. This situation imposes on the test pilot the responsibility for valid and consistent opinions on which design decisions can be based. It is the object of this paper to outline—primarily by use of examples taken from flight-test experience at Ames Laboratory of the NACA—various approaches that have been used in an attempt to assure this validity and consistency. The need for flying qualities requirements to furnish a specific guide for airplane design was recognized in the early 1930's and first resulted in a "check list" of tentative requirements proposed by Warner. The later work on flying qualities by Soulé and Gilruth at Langley Laboratory of the NACA reduced these requirements to more quantitative terms and led eventually to the current specifications used by the military services in evaluating and accepting their own aircraft. Since this early work, the NACA has concentrated its interest with respect to flying qualities requirements primarily on new types of aircraft and on specific problem areas that have arisen. Pilot opinion data have been consistently revised to keep requirements up with changing concepts, missions, and advances in speed and technology. The factors that this work has shown to be of primary importance in influencing pilot opinion are shown in Fig. 1.

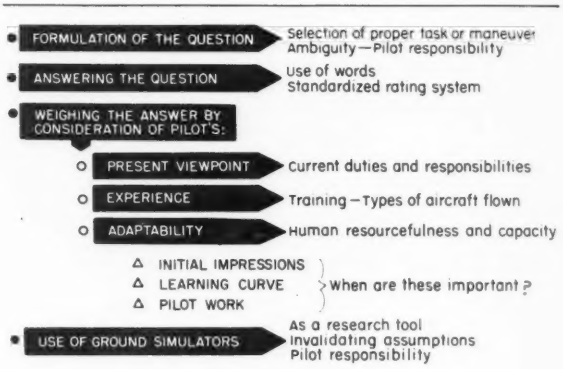


Fig. 1. Factors affecting pilot opinion.

Formulation of the Question

In all the flying qualities work since Warner's day, the first, and perhaps the most important, step has been the "formulation of the question," the choice of the particular factor upon which pilot opinion data are to be accumulated. This is suggested as possibly the most important step since the question in many cases conditions the answer. The test pilot's responsibility, therefore, starts with selection of the factor which is to be evaluated and the task or maneuver on which this factor can best be evaluated. The second step lies in answering the question and is completely the responsibility of the pilot. Next the pilot's answer must be weighed by both the pilot and the engineer in the light of the pilot's present viewpoint, past experience, and adaptability. Certain situations also require consideration of initial impressions, use of the learning curve, or pilot work. Finally, the relatively recent use of ground simulators as research tools has enabled an anticipation of the influence of current design trends on the handling characteristics of future designs, but, on the other hand, it has imposed a new need for care in the interpretation and application of pilot opinion. I shall now attempt to expand on each of the points listed here by drawing examples from flight experience

Presented at the Flight Testing Session, 25th Annual Meeting, IAS, N.Y., Jan. 28–31, 1957.

* Chief Aeronautical Research Pilot.

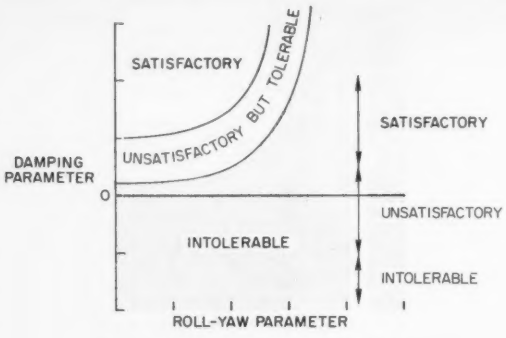


FIG. 2. Lateral oscillation criteria.

that has been acquired in recent years at Ames Laboratory.

Returning now to the first factor—formulation of the question—Fig. 2 illustrates the extent to which it can condition the end result. Shown here are two sets of results obtained from flights in a variable-stability F6F airplane in which the pilots were exposed to a wide range of damping and roll-yaw coupling characteristics. As you can see, the early tests showed a strong influence of this roll-yaw parameter on the pilot's rating. The later tests, which were conducted by some of the same pilots in the same airplane, but in the limited roll-yaw range indicated by the arrows only, failed to confirm this, and the pilots involved were embarrassed by their apparent fickleness and inconsistency. However, this embarrassment was short-lived because examination of the questionnaire on which the later data were based showed that it had changed drastically.

The early questionnaire was somewhat general, and, in arriving at their ratings, the pilots were thinking of normal operation during such tasks as cruise, tracking, or landing. In contrast, during the later tests, their attention was directed by the questions to an emergency condition such as might exist because of the failure of the stability augmenter or a power boost system. It is thus apparent why they were willing to apply the much less stringent requirements shown on the right-hand portion of this Figure for this very limited type of operation. This admittedly is an extreme example, but it is present to a degree in all pilot questionnaires. To avoid ambiguity, questionnaires must be specific enough that a minimum of interpretation is necessary, and care must be taken in condensing information so as not to leave out the essential background information.

ANSWERING THE QUESTION

Returning now to the list of factors that influence pilot opinion (Fig. 1), let us examine the considerations of importance in answering the question. The pilot should realize that his factual report of the experience and his reaction thereto represents the raw data which only he is capable of supplying; any interpretation of the reasons for this experience represents an analysis of the data which he may or may not be in a better position to provide than the engineer to whom he is reporting. There should be a clear separation between these two parts of a pilot's opinion. The ability of test pilots to interpret their feelings in terms of aerodynamic parameters is useful, but it should not be allowed to dominate the basic responsibility of reporting the data—that is, the physical happening, sensations, and reactions involved.

A pilot report or opinion on a particular handling characteristic generally requires the assignment of some adjective rating. A great deal of confusion in interpreting pilot opinion is traceable to the ambiguous meaning of these adjectives. The word *intolerable*, for example, has been given widely different interpretations by different pilots. In such cases the correct interpretation can be ensured only if proper definition is provided on a rating scale. Even the term *acceptable* must be considered on the specific basis of *acceptable—for what?*.

Perhaps a useful contribution that we test pilots can make to the present confused situation is a more specific definition of our adjectives. I would like to suggest the rating system shown in Fig. 3 for consideration.

The rating system shown is broken down into three areas of operation—normal, emergency, and that where no operation is considered. These correspond in general to adjective ratings of *satisfactory*, *unsatisfactory*, and *unacceptable*. Descriptions are given for each numerical rating, and of course the use of fractional values can always afford the opportunity for a finer definition of characteristics when this is desired. Consideration of whether or not the primary mission can be accomplished or the aircraft landed aids in defining more specifically the use of the ratings shown. Such a rating system should apply equally well for specific stability or control evaluations or to the complete airplane.

Clearly indicated are the boundaries between *satisfactory* and *unsatisfactory* characteristics for normal operation and between *acceptable* and *unacceptable* characteristics with the failure of a stability augmenter or other auxiliary device.

Because of the increasing possibility of modifying stability and control characteristics in a desired direction through stability augmentation and artificial feel,

	ADJECTIVE RATING	NUMERICAL RATING	DESCRIPTION	PRIMARY MISSION ACCOMPLISHED?	CAN BE LANDED
NORMAL OPERATION	Satisfactory	1	Excellent, includes optimum	Yes	Yes
		2	Good, pleasant to fly	Yes	Yes
		3	Satisfactory, but with some mildly unpleasant characteristics	Yes	Yes
EMERGENCY OPERATION	Unsatisfactory	4	Acceptable, but with unpleasant characteristics	Yes	Yes
		5	Unacceptable for normal operation	Doubtful	Yes
		6	Acceptable for emergency condition only *	Doubtful	Yes
NO OPERATION	Unacceptable	7	Unacceptable even for emergency condition *	No	Doubtful
		8	Unacceptable - dangerous	No	No
		9	Unacceptable - uncontrollable	No	No
	Unprintable	10	x!@#$%!! Did not get back to report	What mission?	

*(Failure of a stability augmenter)

FIG. 3. Proposed pilot opinion rating system for universal use.

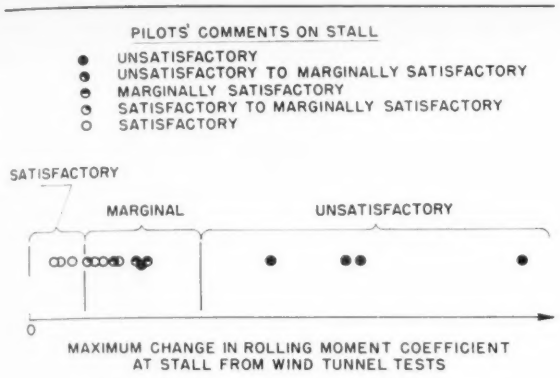


FIG. 4. Wind-tunnel roll-off criterion.

special attention is called to the numerical rating of (1). Correlation of pilot ratings of *excellent* should prove an invaluable aid in establishing optimum characteristics, which will serve a useful purpose in providing an objective, for example, in the design of future control systems. The use of the rating system is not intended to discourage pilots from also using other descriptive—even colorful—words in describing their feelings.

The foregoing discussion of adjective ratings may appear to be a mere quibble on the meaning of words. On the other hand, in view of the important impact of pilot opinion on design decisions, a somewhat universal "calibration" would be most desirable. To this end I have had the temerity to propose the rating scale shown in this Figure. I think this proposal should be considered by test pilots and modified to a point where it can receive common agreement and usage.

Weighing the Answer

Even granting a common agreement on the meaning of adjective ratings, and the numerical scale associated with them, one must expect a degree of scatter in the assignment of ratings for any given airplane or characteristic because of the difference in present viewpoint, previous experience, and adaptability of the individual pilot. For instance, it is to be expected that a research test pilot will tend to be more lenient than a military acceptance pilot, with perhaps a company test pilot somewhere in between. That this is so was vividly illustrated by our experience in the variable stability F6F tests previously described. Numerical ratings were assigned in a manner similar to that indicated in Fig. 3, but we found that the Patuxent pilots were consistently rating a given oscillation characteristic more critical by two or three points than the Ames test pilots. This large difference noted is readily attributable to the difference in viewpoint of an acceptance pilot and a research pilot. I do not cite this as a reason for attempting to change any pilot's viewpoint, but it is a fact of life that should be recognized, and all test pilots, for example, must keep in mind their responsibility to the operational pilot. If, as is frequently the case, a flying evaluation cannot be conducted by a representative cross section of pilots, the individual pilot should recognize his own calibration in relation to the other pilots. At Ames we have done this and recognize various pilots (in and out of our organization) for having, in one case, a preference for neutral stability about all axes; in another, for his perfectionist demands; and a third as a good median.

Influence of Pilot Experience and Adaptability

An extremely difficult variable to allow for in understanding pilot opinion is the gradual, possibly imperceptible, change in the opinion of any given pilot as his experience with the airplane or flight task increases. Initial impressions obtained during the first flight or two on an airplane are usually compared with other airplanes recently flown or those with which the pilot is most familiar. This variation of pilot opinion with time poses some important questions in rating the acceptability of a given handling characteristic. When should the initial impression be of dominating importance? When should the performance at the end of a learning period be the dominating factor? When should pilot work, the degree of concentration required for a given level of performance, be the primary criterion? No universal rule will be proposed here, but different tasks, with different answers, will be cited as examples.

Initial Impressions

Stall represents one characteristic in which initial impressions may be the truer ones. The test pilot may find himself becoming so conditioned to its occurrence, its characteristics, and the corrective action required that he may soon lose sight of his early reactions, with the result that he may be sticking the operational pilot's neck out. Because of this factor, we at Ames have made it a point to record and evaluate separately the initial opinions and the resultant opinions at the completion of a program. This is also extremely useful in the case of flight programs extending over long periods of time. A pilot may refer to his initial report and so modify his overall opinion as to conform to the needs of the operational pilot.

An example of the effect on pilot opinion of pilot familiarity with a given airplane, and how this was handled, is furnished by reference to a recent flight investigation. The purpose of this investigation was to seek a correlation between pilot opinion of acceptable roll-off characteristics at the stall with the wind-tunnel rolling moments as determined on the same airplane when tested in the Ames full-scale tunnel where an unsymmetrical stall could be measured on the wind-tunnel balance system.

The final result is shown in Fig. 4 and represents reasonable agreement among the four pilots involved. However, this required conducting the tests using a modified technique that would minimize the influence of pilot experience. One pilot, who had a high degree of familiarity with the particular airplane configuration,

was able consistently to apply corrective action earlier than the other pilots, thereby not allowing appreciable roll-off to develop. This resulted in his finding as acceptable a stall condition which was characterized by much higher roll-off tendencies than that found as acceptable by the other pilots. The resulting scatter in pilot opinion not only made it difficult to establish a correlation but reflected an influence of experience that ended with a more lenient rating of the stall than was considered to represent the reaction of normal operational pilots. A test technique was therefore developed which involved a simplified and standardized control when the roll-off developed. This minimized the influence of pilots' experience and resulted in the correlation shown on this Figure, which, in the pilots' opinion, represents the proper rating of the stall characteristics. This rating obviously involves a judgment by the pilots involved that the acceptability of stalling characteristics should be dominated by initial impressions rather than by a special control technique which can be learned only by extensive experience.

Learning Effect in Specialized Tasks

In contrast to the stall, there are certain cases involving specialized tasks or procedures, unfamiliar equipment, or unusual stability and control characteristics, in which it is usually necessary for the pilot to establish a learning curve first in order that the overall results are not unduly shaded by any lack of proficiency at the beginning. In such tasks initial impressions and results have to be discounted; the final opinion must be based on the results after the pilot has fully adapted himself to the particular task.

Both the adaptability of the pilot and the use of the learning curve may be illustrated by reference to some flight tests of tracking performance at Ames a few years ago. The tests involved airplanes exhibiting a wide range of stability and control characteristics. In each case the pilot required several flights to become familiar with each of these different characteristics. During this period he would try different control techniques until he found the one that resulted in the minimum tracking error. Once the pilot reached the end of his learning period, it was found he could perform satisfactory tracking even with some obviously unsatisfactory stability characteristics. An F8F, for example, was flown with a modified rudder that produced a rudder-free static directional instability. Even though the pilot complained about the rudder characteristics, he was able to track just as well as with the normal rudder. In this case the pilot adopted a technique of clamping both feet hard against the rudder to overpower the force feedback and made all his rudder corrections by displacement alone rather than by feel. In similar tracking tests using the same standardized maneuver a large variation in stick force per g and control effectiveness was investigated, but no important variations in measured tracking proficiency were found.

A similar dominant effect of pilot learning has been noted in tracking tasks using the scope-presentation type of fire-control system. Aim wander in the first attempts shows a wide variation on successive runs. In due course pilot proficiency increases, and the aim wander stabilizes at a level that can be considered indicative of the tracking effectiveness of the airplane-fire-control-system combination. While in each of the tracking examples presented the use of a learning period was found to be of primary importance, the first example also was illustrative of the manner in which pilots use their adaptability.

Pilot Work

In many tasks, such as the tracking tasks just discussed, this adaptability is such that it compensates for any deficiencies in the system, and the end result, such as aim wander, is the same in an obviously poor system as it is in the best system. The thing that distinguishes the two systems is the as yet unmeasurable, intangible "pilot work" or concentration necessary to attain this level of performance. In some cases the addition of a distracting task such as the separation of varicolored balls has been added to the pilot's duties with the thought that this would deteriorate the performance of the primary task on the poor airplane more than it does on the good one. In other cases an attempt has been made to use the learning curve itself to indicate the difficulty level of the task. To my knowledge, neither of these expedients has given definitive results. Until the psychologists come along with some sort of device for measuring pilot work or concentration, the chief reliance will continue to be placed on "pilot opinion" of the various degrees of acceptability of pilot effort involved in performing a given task with a particular airplane, control system, or auxiliary device.

Use of Ground Simulators

The relatively recent use of ground simulators in which a human pilot is one part of the loop has imposed on the test pilot a new type of responsibility. These simulators can potentially furnish a means for evaluating a particular airplane or control-system characteristic well in advance of actual flight so that a modification can be more readily introduced. On the other hand, such a simulation cannot include all the factors that influence a pilot's reactions or opinion, and there exists the danger that one of the factors of primary importance will be left out, and the simulation will lead to an invalid conclusion. The contribution that a test pilot can make here is obvious. Because he can compare both his reaction and opinion when subjected to duplicate tasks in the air and on the ground, he is in the best position to assure that the ground simulation is a good one.

In many cases the simulators are motionless, and the important question, to which only the pilot can give an answer, is to what extent has the elimination of motion stimuli influenced his ability to perform the task. There is obviously no universal answer to this question, and each task must be examined on its own merits. In one

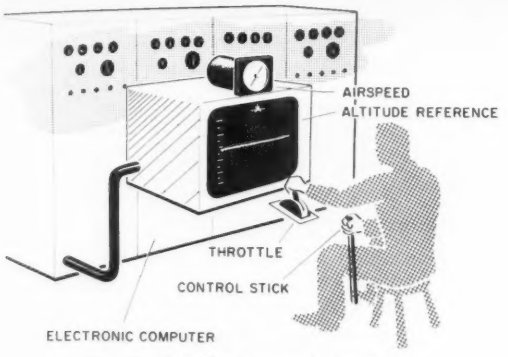


FIG. 5. Landing approach simulator.

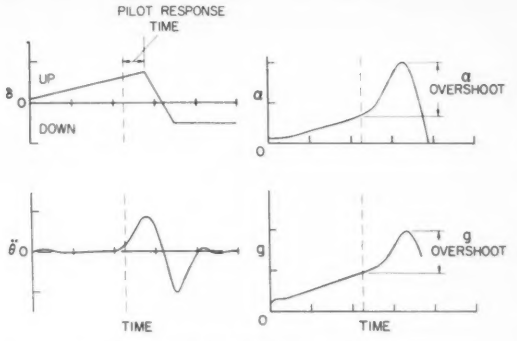


FIG. 6. Synthesized pitch-up maneuver.

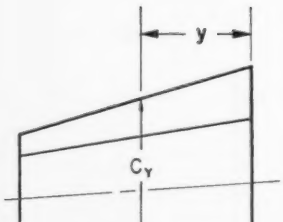
case, that of using the ground simulator to determine the minimum comfortable landing speed, we have found that the effects of motion can be ignored. The factors influencing the pilot in the landing approach are many. However, flights on a number of airplanes revealed that, in the absence of buffet, proximity to the stall, or attitude and visibility problems, the pilot would limit the landing approach speed depending upon his ability to control altitude or check the sinking speed. This led to a ground simulation as shown on Fig. 5 in which a very simplified model of the airplane was represented and the basic aerodynamic parameters which influence his rate of sink were simulated. The pilot was provided with a control stick, air-speed indicator, and altitude reference system, as shown. A visual indication of an airplane near the top of the screen provided the pilot with the necessary reference needed for visualizing gain or loss of altitude in response to control motion. While the first attempts indicated that the representation of the airplane had been oversimplified, the pilots were able to suggest necessary additions in the form of a throttle incorporating proper thrust characteristics, stall warning, and a random disturbance so that satisfactory correlation could be obtained. In this task it was not necessary to subject the pilot to any motion stimuli to represent properly the important flight conditions. The simulation described here was good enough so that any errors in simulating the aerodynamics of different configurations were readily apparent to the pilot, and, in many cases, he was able to point out these errors before the engineer running the simulator was conscious of their existence. I sometimes suspected the engineer of purposely leaving out a circuit now and then to see if the pilot was awake.

In contrast to the foregoing, another piloting task on which motion stimuli were found to be of primary importance is the pitch-up. As you know, an uncontrolled pitch-up is associated with an unstable pitching moment. If it were not for the presence of the pilot, who is attempting to check this pitch-up, the severity could be judged to a large extent on the basis of sharpness of the pitching-moment break. However, the severity and acceptability of the pitch-up are usually moderated by the pilot's ability to sense it and apply corrective control. A successful simulation obviously depends upon identifying the motion factors which enable him to sense the onset of the pitch-up. In our investigation, ground studies were made with a pitch chair which, in conjunction with the pilot's opinions, enabled us to eliminate a number of factors, such as increase in g, pitching velocity, etc., as the important motion stimulus. It was finally determined, under the direction of the pilot's opinion, that pitching acceleration was the primary motion stimulus to which he was sensitive. Tests with a number of pilots who had considerable experience in actual flight pitch-ups revealed a pitching acceleration threshold and an average reaction time in the application of corrective control. We have used this information to synthesize a typical pitch-up maneuver, which is shown in Fig. 6. Control deflection δ, pitching acceleration $\ddot{\theta}$, angle of attack α, and normal acceleration g are all shown plotted as a function of time. The pilot control is applied at a given rate. At the point, indicated by the dotted line, pitching acceleration has reached its threshold value and the pilot decides to apply corrective control. Because of the typical lag due to pilot response time, corrective control is actually not applied until a moment later and pitching acceleration has increased as shown. An overshoot in acceleration and angle of attack then occurs which is also a function of the recovery control rate used.

The validity of this synthesized simulation has been proved by comparing the pilots' opinions of the pitch-up characteristics of six different airplanes in which they also had flight experience. A good correlation was obtained. All airplanes were rated in the proper order of merit. We thus have a ground simulation method which we can use with some confidence on airplanes not yet flown to determine the probable pilot's opinion of pitch-up characteristics and to evaluate effectiveness of various changes that may be considered in a design to moderate the severity of pitch-up. The thing that makes this simulation work is the proper identification by the pilots of the motion stimulus which provides the most important signal to them in their control of this maneuver.

There is still another task, for which we are trying to find the answer, which involves the question of whether or not motion is required to simulate the flying condi-

(*Continued on page 56*)



Mervyn G. Heal*
Lockheed Aircraft Corporation

Problems in Estimating Structure Weights

A presentation of some of the procedures that can help achieve greater accuracy in the estimation of structural weight.

Introduction

This paper is an attempt to present briefly some of the problems in estimating structural weights of high-speed airplanes and in particular low aspect ratio wings.

This is an opportune time to review weight estimating procedures in view of the added responsibilities brought on by the new Research and Development Command procedure in the procurement of new airplanes. Previously a detailed specification was given to the contractor which laid down speeds, range, altitude, etc., and the problem was to find the best airplane which satisfied the prescribed conditions. In some cases impossible combinations of performance requirements were encountered, and in general the services expected a little more for their money than we were able to give. The main objection to this method was that it restricted the manufacturer to the narrow field given in the specification. With the new policy, we are presented with a problem in interception, bombardment, etc., and then study the various methods by which the problem may be solved. The study can cover large variations in speed, altitude, range, load factor, etc., in the search for the best compromise between cost and performance. There is no need to emphasize the importance of our work here since both cost and performance are so sensitive to weight. It behooves us then to refine our weight estimating methods in order to be capable of determining accurately and rapidly the effects of speed, load factor, etc., in addition to making our estimates more accurate during the configuration studies. This effort will allow us, when the project phase is reached, to account in detail for the weight allocated and the design conditions and assumptions upon which it is based. It is felt that this will be of considerable help in the initial weight activity.

The aerodynamic characteristics of an airplane are considerably changed in going from subsonic to supersonic flight. The loading of the structure is to some extent affected by these changes, and we must be aware of what these changes are and to allow for them. Although accuracy in weight estimating methods is important on all airplanes, it is essential for the true and accurate analysis of a supersonic airplane. With the current afterburning jet engines, it takes roughly three times as much fuel to carry 1 lb. of weight a mile at Mach 2 than it does at Mach 0.9. Prolonged flight at high speed requires phenomenal amounts of fuel, and this fuel is usually housed in a long thin fuselage. Consequently the growth factors we are working against are much higher than those experienced on the present breed of fighters which are supersonic for relatively short periods of time.

The need is there. It remains now to find a means to perform these desirable duties. At Lockheed we believe we have achieved some success in our attempts to estimate weights of high-speed airplanes and the effects of the parameters which influence these weights. Here then is a brief description of some of the pertinent items. If the material presented is too general, please forgive me; the scope of this paper however does not allow the detailed analysis which many may think to be beneficial.

A great volume of material already exists on wing estimation, and it would seem that any addition to this

Presented at the September 26, 1956, meeting of the Los Angeles Chapter of the Society of Aeronautical Weight Engineers under the title "A Dissertation on the Problems Associated With Estimating Structure Weights on Supersonic Airplanes With Particular Regard to Low Aspect Ratio Unswept Wings."

The author would like to express his thanks to the California Division of Lockheed Aircraft Corporation and especially to the Weight Department for the assistance he has been given in preparing this paper.

* Design Weight Engineer, California Division.

would be superfluous. The wing however is subject to most variation in configuration studies, and we still have problems in making good estimates.

Structural Design Conditions

During the configuration stage of a design, there are little, if any, aerodynamic or load data available, and, since the first requirement in estimating the structural weight is to determine the critical loading condition(s), it is often necessary to make our own load estimates.

The loads in the structures arise from flight maneuvers, gust, and ground handling. On high maneuver load factor airplanes, the maneuver condition is invariably critical for all the primary structure. This simplifies the analysis by a considerable amount. Unfortunately, optimizing a configuration and determining the best method to fly in order to accomplish a specific mission frequently involve investigating all three in detail. In this type of study the maneuver load factor is given either by regulation (CAA, BuAer, or Air Force) or by studying the aerodynamic capabilities required of the airplane at the critical point of the mission. The gust conditions have to be investigated over the range of wing loading encountered during a design mission in an attempt to minimize the structural and performance penalities involved.

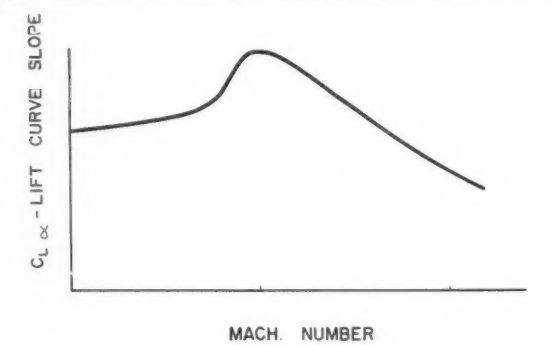


Fig. 1. Variation of lift curve slope with Mach Number.

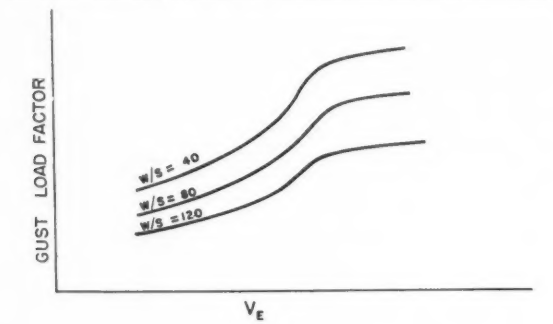


Fig. 2.

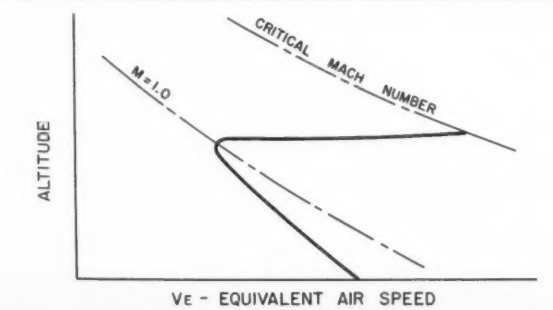


Fig. 3. Speed altitude capability for constant gust load factor.

$$\text{Gust limit load factor} = 1 + [KC_{L_\alpha}V_E/(W/S)]$$

where

C_{L_α} = airplane lift curve slope
V_E = equivalent air speed
W/S = wing loading
K = a factor dependent on the gust criteria of the licensing agency, accounting for gust velocity and alleviation factor

C_{L_α} varies with Mach Number in a manner shown in Fig. 1. This means that, for a constant wing loading and constant V_E, the load factor will vary considerably with altitude.

At a constant altitude, the variation of load factor with V_E is shown in Fig. 2 for a number of wing loadings. This type of curve is useful to check the critical conditions when they are not too obvious by inspection.

Fig. 3 gives V_E variation with altitude with constant wing loading and load factor, with a cut-off at the critical Mach Number. When the maneuver load factor is used to prepare the curve, it gives the speeds at which the airplane can fly with no structural penalty due to gust. This is extremely useful in setting up the aircraft placard speed.

Ground loads can have considerable effect on the structure weight when large masses are concentrated away from the airplane center of gravity. This is particularly true of tip tanks or any body outboard on the wing when there are no outriggers fitted. The section on wing loads will indicate how critical this can be when negative load factors build up during ground handling maneuvers.

Air Load Distribution

It has always been desirable in structural weight estimation to be able to arrive at a good air-load distribution. On aircraft with low aspect ratio wings, the need is increased because of the large part of the wing buried by the fuselage and the high negative tail loads encountered in supersonic flight.

$$\text{Airplane lift} = L_W + L_B \pm L_T = Wn$$

where

n = limit load factor
L_W = lift on exposed wing panels
L_B = lift on body and buried wing

L_T = lift on stabilizer which can be positive or negative

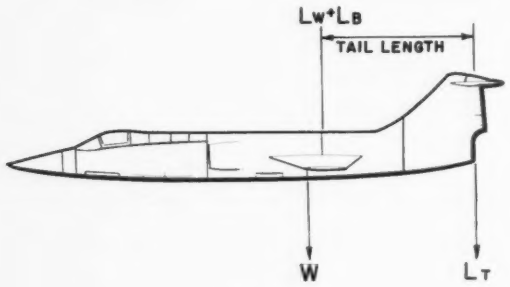


FIG. 4.

The tail load for supersonic flight is always negative, and L_T can be estimated by assuming the center of lift of the airplane less tail to be at 50 per cent M.A.C. The balancing tail load is approximately

$$L_T = \frac{-Wn \text{ M.A.C. } (0.5 - x_{c.g.})}{\text{tail length}}$$

where

M.A.C. = wing mean aerodynamic chord
$x_{c.g.}$ = airplane center of gravity at weight W as a fraction of the M.A.C.
tail length = distance 50 per cent wing M.A.C. to 50 per cent tail M.A.C.

Then

$$L_W + L_B = Wn\left[1 + \frac{\text{M.A.C. } (0.5 - x_{c.g.})}{\text{tail length}}\right]$$

Reference 1 gives a method for distributing the lift between the body and exposed wing panels.

When bodies are fitted at the wing tip, there is a change in the lift distribution due to the lift generated by the tip body. It is convenient in this case, in the preliminary stage, to distribute the positive lift among the body, exposed wing, and tip bodies. Reference 2 indicates how to determine the value of the tip lift.

WING WEIGHT ESTIMATE

The lift is now distributed between the various components so the stage is set to proceed with the wing weight estimate. The bulk of the wing primary structure weight is in the wing panels to carry wing bending loads. In order to obtain the bending moment distribution, an estimate has to be made of the spanwise lift distribution. Except for the case when the exposed panel is broken by an engine nacelle or some such protuberance, a uniform area distribution can be used. The bending moment can now be calculated, taking account of the tip lift and the inertia relief of the tip body and the wing.

The material required at any section to carry these loads =

$$[M_y/C_y(T/C)_y\, K_d f_c] + [M_y/C_y(T/C)y\, K_d f_t]$$

where

M_y = ultimate bending moment at station y
C_y = wing chord at station y
$(T/C)_y$ = thickness/chord ratio at station y
K_d = effective depth between panel centroids/maximum depth
f_c, f_t = allowable compression and tension stresses at station y

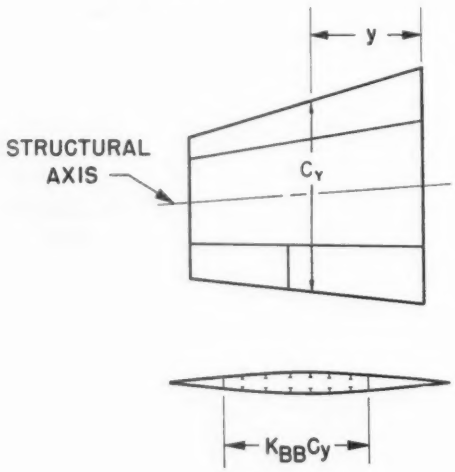


FIG. 5.

F_c and F_y can best be obtained from statistical curves of panel load/inch against allowable stress. Fig. 6 illustrates how this can vary on a wing with 75S-T6 panels.

$$\text{Load/inch} = M_y/(C_y^2)(T/C)_y\, K_d K_{BB}$$

where K_{BB} = box chord/total chord.

It is suggested that statistical data be used because we are primarily interested in gross area stresses which will take care of joint efficiencies and the degree of taper that can be achieved in production. The gross area stress curves can also be made to include the loss of material properties which result from aerodynamic heating.

$$\text{Weight/inch of panels} = 2M_y w/C_y(T/C)_y\, K_d(f_c + f_t)$$

where w = weight of material lb./in.^{3}.

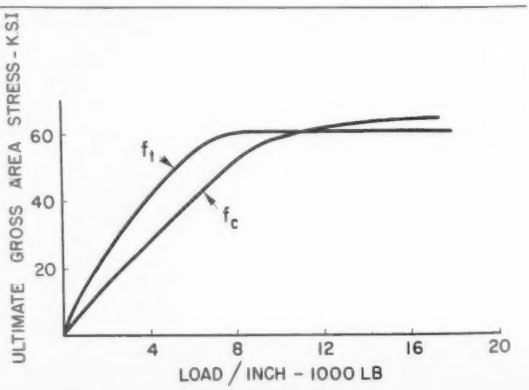


FIG. 6. Gross area stress vs. load intensity.

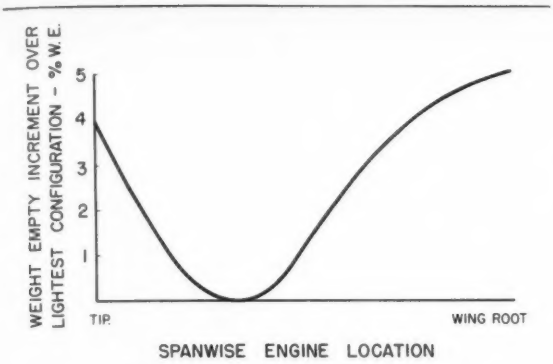


FIG. 7. Wing weight variation with engine location.

This analysis needs to be carried out for ground handling, maneuver, and gust loads in order to establish the critical condition at each spanwise station. Integrating along the exposed span an envelope of weight/inch covering all the critical conditions will give the panel weights. To this must be added weight for joints, splices, etc., in order to obtain the weight of material required to carry bending loads.

In optimizing the location of engines, stores, etc., an appreciable variation in wing weight has to be considered. This variation of wing weight should be combined with fuselage penalties when this is the alternative location. Fig. 7 shows the wing weight penalty when a location other than the one which gives least weight is selected. This variation applies only to the design for which it was derived and is not necessarily representative although it indicates the order of magnitudes we are dealing with.

Nothing has been said of the internal box beam structure or the leading- and trailing-edge structures. The spars and ribs in the box beam can be influenced to a large extent by the production problems with small thin wings, and in this case the internal structure can become a larger proportion of the box beam weight than on more conventional wings. As the wing size increases, it appears that this tendency will be halted, and the internal structure need be no heavier than on airplanes flying today. The leading- and trailing-edge structures are subjected to higher loads due to the increased chord lengths. A structural type of analysis of these structures can be made in the normal fashion. The critical design case on the leading edge is usually a subsonic condition; on the trailing edge it will be a supersonic condition.

Aeroelastic Effects

This is probably the most complex weight problem we are likely to encounter, and we have not been able to devise a method, which is usable in the preliminary design phase of a new design, to estimate the weight penalties involved. We have however been able to scratch the surface of the problem, and the conclusions we have reached may be of some value.

The problems that arise because of the nonrigid characteristics of the wing are divergence, rolling effectiveness, flutter, and—with low aspect ratio wings—chordwise bending deformation.

Wing divergence can be avoided fairly readily when the wing box is swept back to some moderate angle such that the weight penalty due to wing sweep is quite small. It appears, too, that the weight penalty for chordwise bending deformation can be eliminated or at least kept small by adjusting the wing camber to some optimum amount.

Rolling high-speed airplanes has been a problem of some magnitude for years. This is evidenced by the systems that have been employed on swept high aspect ratio wings with inboard ailerons, outboard ailerons, and spoilers in a complex control system designed to be capable of rolling the airplane throughout its speed range while keeping the structural weight penalty to a minimum. Rolling systems for low aspect ratio wings are less complex than these only because we have less span on which to hang all this gadgetry and make it work. We are then left with a conventional aileron system, and its effectiveness is maintained by providing adequate torsional stiffness in the wing box beam. A method to determine the skin thickness required to give satisfactory torsional rigidity can become quite complex so in order to obtain a quick solution simplifying assumptions must be made. The loss of rigid wing rolling performance arises from torsional deflections and from bending deflections when the structural axis is swept to some angle. Since this paper deals with essentially unswept wings, the bending deflection will be neglected.

$$d\theta/dy \propto (TP/GA^2t)$$

where

$d\theta/dy$ = rate of change of twist
T = torque due to aileron load; assumed proportional to (wing area) × (chord at 0.75 semispan) × V_E^2
P = box beam perimeter $\propto [1 + (T/C)]C_y K_{BB}$
G = modulus of rigidity of skin material
A = enclosed box beam area $\propto C_y^2(T/C)$
t = skin thickness

Now if the twist at the wing tip is used as the criteria

$$\int_0^{b/2} d\theta \propto \frac{TP\,b}{GA^2t}$$

When data are available on an existing wing, the skin thickness required on a new design can be estimated using this relationship.

$$\text{Skin thickness } t_2 = t_1 \frac{AR_2^{3/2}\ S_2^{1/2}\ V_{E_2}^2}{(T/C)_2^2\ K_{BB_2}} \frac{(T/C)_1^2\ K_{BB_1}}{AR_1^{3/2}\ S_1^{1/2}\ V_{E_1}^2}$$

where AR = aspect ratio of exposed wing, S = area of exposed wing, subscript 1 indicates data on an existing wing, and subscript 2 indicates the new wing. The

critical Mach Numbers and wing geometry of the two wings must be quite similar.

This approach can be used when there are differences in aileron-wing geometry and Mach Numbers, provided allowances are made for these differences. In this case it is advisable to make the torque induced by the aileron proportional to the product of aileron span or aileron area, distance 50 per cent aileron M.A.C. to the structural axis at this spanwise location, and V_E^2. The correction for Mach Number is to allow for the variation with Mach Number of the chordwise pressure distribution due to aileron deflection.

It should be emphasized that this method should be used with caution. The short cuts that have been made are quite legitimate, provided there is a constant awareness of the errors which can arise if the assumptions are invalidated. At Lockheed we have one of these high-speed beasts flying (quite successfully, too, I might add), and, having passed this initial hurdle, we are able to capitalize on it to the full.

The weight penalty to achieve an adequate level of torsional rigidity can be obtained by taking the difference between skin thickness required for the load carrying box beam panels and the thickness required for torsion. The incremental increase integrated along the wing span will give the weight penalty in the wing for effective aileron operation.

The flutter problem can be eliminated easily by assuming that satisfying the aileron condition will ensure that no undesirable flutter condition is encountered. We have convinced ourselves that this is true and in doing so have walked away from a substantial amount of work which gave no solutions.

References

[1] Nielsen, Jack N., and Kattari, George E., *Methods for Estimating Lift Interference of Wing Body Combinations at Supersonic Speeds*, NACA RMA51 504, 1951.

[2] Silvers, Norman H., and King, Thomas, J., Jr., *Investigation at High Subsonic Speeds of Bodies Mounted From the Wing of an Unswept-Wing-Fuselage Model, Including Measurements of Body Loads*, NACA RML52J08, 1952.

▲ ▲ ▲

Air Safety Problems (Continued from page 46)

the Seminar, at Palm Beach Shores. Admiral John H. Cassady, FSF Executive Vice-President, and Jerome Lederer, Managing Director, presided and made the welcoming remarks and presentations.

The four FSF Awards for Distinguished Service in Achieving Safer Utilization of Aircraft, presented by FSF on behalf of *Aviation Week* magazine, went to Melvin N. Gough, Head of Flight Research, NACA, Langley Field, Va.; Arthur E. Jenks, Chief of Flight Inspection, CAA; William Littlewood, Vice-President, Equipment Research, American Airlines, Inc.; and Dr. Edward P. Warner, President of the Council, ICAO.

An interesting, self-taken documentary film on World War I aviation was presented by Major Kimbrough S. Brown following the dinner.

▲ ▲ ▲

Understanding and Interpreting Pilot Opinion (Continued from page 51)

tions properly. This is a tracking task using a scope presentation. Comparison of ground simulation and flight tests of variations in this presentation have resulted in diametrically opposite results. The pilots reported that their reactions in attempting to control a dot on the scope are quite different when their only stimulus is visual, as on the ground, from their reactions when they also have motion stimuli in the air. This study is continuing in order to determine just what is the important motion, and the pilots' comments are obviously of primary importance in determining which should be simulated and which can probably be neglected.

Conclusion

In conclusion, it is felt that perhaps the most important factor in obtaining reliable pilot opinion lies in the formulation of the proper question or task to be asked the pilot. In answering this question, which ideally the test pilot has helped to formulate, he must express his opinion at some time or other in terms of an adjective rating system. As a step toward a more universal calibration of pilot opinion, some standardization in rating systems would be desirable.

The expression and interpretation of pilot opinion must consider also such factors as the pilot's present viewpoint, background, experience, and adaptability.

It is also concluded that ground simulators in conjunction with a human pilot are valuable tools for evaluating a particular airplane or control system characteristic, but, because of the very real danger of making invalidating assumptions, it is important that the test pilot share the responsibility for their design and use.

The role of the flight surgeon in aviation accident prevention is twofold: his analysis of so-called pilot-error accidents and his constant and skilled supervision of the pilot's flight readiness.

The Flight Surgeon and Aircraft Accidents

Capt. Carl E. Wilbur* (MC), USN
Office of the Deputy Chief of Naval Operations (Air)

AVIATION SAFETY has become a big business in the Navy. The Naval Aviation Safety Center at Norfolk, Va., which was established late in 1951, doubled its staff from 27 to 56 personnel in 1954. In 1955 further expansion brought the staff up to its current strength of 88. 1957 will see the assignment of an officer of flag rank as Director of this center.

Having technical control over this establishment is a small office in the Pentagon. This office is known as the Division of Aviation Safety and is a part of the aeronautical organization under the Deputy Chief of Naval Operations (Air). So much for the headquarters of the safety business.

Two other major parts of the safety organization are worthy of mention. One of these is the Safety Council, which may be considered as the Board of Directors of the business. There is a Chief of Naval Operations Safety Council which meets periodically in Washington, D.C. In addition, there are about 25 Area or Major Command Aviation Safety Councils which meet monthly and submit quarterly reports to the Chief of Naval Operations.

A second important part of the safety organization is the staff and squadron safety officers. These officers, who may be thought of as the district managers of the business, are trained at the Aviation Safety Officer School at the University of Southern California and assigned to primary duty billets involving aviation safety.

Representing, as I do, the Aero-Medical Section of the Division of Aviation Safety in the Office of the Deputy Chief of Naval Operations (Air), I am concerned in the following with the role of the flight surgeon in aviation safety. As you may know, the Naval flight surgeon is trained at the School of Aviation Medicine in Pensacola, Fla. The graduates of this school for the past few years have been, with few exceptions, young physicians who are serving their 2 years of obligated military service.

Two recent developments relating to flight surgeons are important in any consideration of their role in military aviation. One of these is the career incentives program which should lead to the presence of more career flight surgeons in the Navy. A second development is the recognition, as of 1954, of the specialty of aviation medicine. The American Board of Preventive Medicine now certifies specialists in aviation medicine just as surgeons, skin specialists, and other medical men are certified by their specialty boards.

We have spoken briefly of the safety organization and some of its important components. One should not lose sight of the fact that organizations are made up of people and that programs are carried out by people. The capacities, training, motivation, and goals of

The flight surgeon "has also been called upon in the development of protective flight equipment."

Presented at the Medical Aspects of Aircraft Accident Investigation Session, 25th Annual Meeting, IAS, N.Y., Jan. 28–31, 1957.

* Head, Aero-Medical Section, Aviation Safety Division.

individuals—these factors are the basic ingredients of any program. What these people and, in particular, the flight surgeons are doing and what they can do to improve aviation safety are the considerations under discussion.

First, a brief review of what happens when an aircraft accident occurs. "Here we go again" expresses the view of the old safety hand—much as Peter Arno's cartoon of a few years back depicts the aeronautical engineer, turning from the still smoking aircraft crash, saying "back to the drawing board."

The instruction which covers the investigation and reporting of accidents is 50 pages in length. Exhaustive studies are made, and detailed reports of each accident are submitted up the chain of command. The local commander may take his own corrective action. But the final resting place of all the reports and endorsements is the Safety Center where analysis gives rise to statistics and further reports. Finally, the impact of all this effort on headquarters is considerable.

One might pause here and reflect upon the vast expansion of the safety organization in the past few years. Two considerations come immediately to mind:

The first observation is that aircraft have become very costly and complex. When one considers that it may cost in the neighborhood of $150,000 to train a Naval aviator and that one single aircraft which he flies may involve an expenditure as high as 5 or 10 million dollars, it becomes obvious that the entire safety effort can be paid for with the prevention of a single aircraft accident.

A second observation, as we reflect upon the recent expansion of our safety organization, is only slightly less obvious: We are in a period of transition as regards manned flight. A few years back the flight surgeons could relax a bit as they looked down the street at the aeronautical engineers in their laboratories. The sound barrier appeared to present insurmountable difficulties. Suffice it to say that the engineers overcame this obstacle in jig time and left the flight surgeon trying to catch up with his pilot's protective equipment. What the ultimate development of the flying machine, controlled by a pilot, will be, I cannot say. It would appear, however, that the engineers have placed no limit on the prospects for the future. When the F-104 flew by the reviewing stands last September in Oklahoma City, the announcer said, "Here it comes, the ultimate in aircraft, a missile with a pilot inside." I am tempted to say that I doubt whether the flight surgeon will ever be able to catch up with the engineer. But such an admission would deny the fact that it is man, himself, who wants to fly higher and faster.

A third consideration, as we reflect on the scope of our safety efforts, requires a brief introduction. Traditionally, the flight surgeon is expected to perform all the duties of a medical officer. He has also been called upon in the development of protective flight equipment. And his concern over the human engineering of cockpits has brought him, without doubt, to the attention of many aeronautical engineers. Although the flight surgeon's wagon is hitched to most of the stars in the aeronautical sky, in his day-to-day duties as a squadron medic he is the jack of all trades par excellence. Variously called to perform as psychiatrist, father confessor, wet nurse, confidant, etc., his scouting duties are legion.

So much for a broad background to the aviation safety scene with its people and the flight surgeon in particular. We come finally to the foreground of our picture and an attempt to paint the flight surgeon in two roles critical to a meaningful study of aircraft accidents.

You will recall that our second consideration, as we reflected on the expansion of safety efforts, had to do with a period of transition. Such a state of affairs implies, in modern parlance, a barrier of one kind or another. Our third consideration, then, is this: I believe that we are confronted with what might be termed the "human barrier." This barrier corresponds perhaps to the heat barrier, or some other barrier of which I am unaware, which presently confronts this audience. Whether or not we make a breakthrough in this human barrier will depend on the flight surgeon's competence in two undertakings.

The first of these is his analysis of so-called pilot-error accidents. In 1955, 64 per cent of the Navy's aircraft accidents were attributed to this cause. Only 22 per cent of the accidents were attributed to material failure. How much do we truly know about two out of every three of our accidents? To call them pilot error is to admit that we know very little about them. To my mind, it is like saying that in one out of five of our accidents something went wrong with the airplane—and letting it go at that. There is a crying need to get down to the nuts and bolts, as it were, of the pilot and his environment as we invariably try to do in a material-caused accident. Furthermore, to call two out of three accidents the result of pilot error is to incriminate sorely our training activities. I do not believe that such a point of view is justified. Consider for a moment an example of an accident about which there can apparently be no doubt as to its classification in the pilot-error category: A pilot lands with his wheels up. On close scrutiny we find in more instances than not, that, in a crucial stage of his approach to landing—an approach which the advent of jet aircraft has rendered far more critical in terms of the pilot's attention and skill than was the approach in a prop plane—in that crucial moment in his check-off procedure when he is expected to lower his wheels, we have interrupted this critical procedure with some interference from the outside, such as a garbled radio transmission. In short, we have asked our superhuman-man - supersonic-machine system to operate in a horse-and-buggy environment, one which has not changed appreciably during the transition from props to jets. Those pilots whom we consider our best pilots will react in this atavistic environment precisely as our poorest pilots will react; they will forget, overlook, neglect, or otherwise fail to lower the landing gear. Is this an error on the part of the pilot

or an error we have failed to eliminate from or, in fact, have built into the environment of our supersonic aircraft?

Or consider the pilot who flies his advanced aircraft into a tow banner. This, to our classifiers, is without doubt a pilot-error accident. But a closer look reveals that we have already come to the conclusion that plane-to-plane combat, as we knew it in the days of prop aircraft, is in a state of transition to a type of aerial warfare wherein the pilot will fire his missiles without ever seeing his target with the naked eye. By the time our pilot sees the tow, it will be too late to take evasive action. Again, have we not placed our subject in a supersonic craft and asked him to water-down the capabilities of his machine, so to speak, to an outmoded maneuver—and then proceeded to attribute the errors in such an impossible situation to the pilot?

There are many analogous accidents which fall into the catch-all category of pilot error. Fifty per cent of all accidents occur in the landing phase of flight. The aerodynamic qualities of supersonic aircraft would appear simply to be incompatible with their routinely safe return to a stop on the ground. If such were not the case, I fail to see why we should expect such a preponderance of accidents in this single phase of flight.

As a fourth example of a situation wherein our pilot can do nothing but err in the performance of his task, consider the jet pilot who reaches forward to trip an arming switch in a relatively inaccessible cockpit location. In the process he inadvertently presses against—I might say he is forced to press against—the stick. In a jet aircraft, a mere 2° nose-down attitude can result in a 1,000-ft. loss of altitude in 0.2 sec. Should we say that the pilot errs in such a situation or rather that we have stacked the deck against him?.

The sympathies of the flight surgeon should be on the side of the pilot. I, too, would get tired of the pilot-error stigma being attached to the majority of accidents occurring in the flying occupation which is my profession.

As was mentioned earlier, a breakthrough in the human barrier will depend, I believe, in the first instance on the flight surgeon's competence in the detailed analysis of so-called pilot-error accidents. I have mentioned only a few of the possibilities which this category presents as a challenge to the diagnostic acumen of the flight surgeon.

With the second undertaking demanding the most skilled efforts of the flight surgeon I shall conclude. Dr. Webb, of the Navy's School of Aviation Medicine and an authority on the psychological factors in aircraft accidents, recently made the following observation before the Navy's Air Board: "The elimination of accidents appears to be primarily dependent upon modifying the conditions of flying and a constant observation of pilots in regard to the momentary states of flight readiness by flight surgeons in contrast to the selection of individuals." I should also like to quote from an address by Admiral Radford before the Association of Military Surgeons last November. Speaking of the military posture of the man in uniform, he said, "Does the individual officer in some key position of responsibility have a reasonable medical understanding of the "why" in heart disease? Does he know how he might minimize some of the causes of this serious disability? And is he aware of the serious physical detriments involved in obesity? Then take our young military specialists—our jet pilots, submariners, guided-missile experts, and the like—do you think that they really understand the dynamic forces of nuclear power, supersonic speeds, toxic chemical fumes, electricity, and high altitudes? Do they know the different forces which can surge through their bodies and what their different effects will be?"

The second vital task of the flight surgeon is clearly delineated by these two quotations. The constant supervision of the pilot's flight readiness by the flight surgeon and the highest degree of indoctrination in his superhuman flying task given the pilot by his flight surgeon—these are two of the most important, yet often too lightly considered, jobs in preventive medicine and accident prevention that we have. The aeronautical engineer and the physician must never overlook the fact that their intimate knowledge of aerodynamic and medical lore results from long periods of study, disciplined observation, and practice. The young aviator is not noted for his scholarship, yet his life and the successful performance of his military mission depend on the degree to which he puts into practice the theories of aerodynamics. The young pilot is not noted for his understanding of physiology nor even of the psychological processes with which he makes his way through the skies. Yet, again, his life and the completion of his mission depend on his practical application of the wisdom known in these fields. In short, we must teach and counsel and supervise every step in his progress toward mastery of his aircraft. We must not allow his craft to get ahead of him through our neglect. When we have all done our jobs thoroughly, we will see the human barrier crossed and the advent of the accident-free, professional pilot.

▲ ▲ ▲

Necrology (Continued from page 31)

Frederick Sigrist

Frederick Sigrist (F), of Nassau, Bahamas, former Joint Managing Director of the Hawker Siddley Group and Hawker Aircraft Ltd., has died at his home. He was 72.

Mr. Sigrist, a Member of the Order of the British Empire, had retired to Nassau after a lung operation in 1939.

He joined Sir Thomas Sopwith in 1910, as engineer of an auxiliary schooner, a job that included looking after (then Mr.) Sopwith's pet bear. Mr. Sigrist was mainly responsible for design of early World War I Sopwith airplanes. He was the first Works Manager and General Manager of Sopwith Aviation and Engineering Co., Ltd. This firm is reputed to have built more fighters during World War I than any other manufacturer.

A Fellow of the Royal Aeronautical Society, Mr. Sigrist was privately educated. He also was a member of the Royal Aero Club.

Joseph A. Wise

Word has been received of the death of Joseph A. Wise (AF), Professor of Aeronautical Engineering at the University of Minnesota, on August 25. He was 59 years old.

Before joining the faculty at Minnesota, Professor Wise had been a Design Specialist at Convair, A Division of General Dynamics Corporation. He had taught aeronautical and civil engineering since 1928.

Professor Wise also had been a Research Specialist for NACA and Lockheed Aircraft Corporation. He was a registered Professional Engineer and a member of the American Society of Civil Engineers and the Minnesota Association of Professional Engineers.

He was born in New York City, attended high school in St. Louis, and was a graduate of the University of California. He became an Associate Fellow of the Institute in 1937.

NEWS OF MEMBERS

▶ **Alan Pope** (AF), formerly Supervisor of Experimental Aerodynamics, has been appointed Head, Aerodynamics Department, for the Sandia Corporation of Albuquerque, N.M.

▶ **Wolfgang B. Klemperer,** founder member and Fellow of the Institute, has been presented a fellow award by the American Astronautical Society. Dr. Klemperer is Chief of the Research Section, Missiles Engineering, at Douglas Aircraft Company, Inc., Santa Monica Division.

Members on the move . . . .

This section provides information concerning the latest affiliations of IAS members. All members are urged to notify the News Editor of changes as soon as they occur.

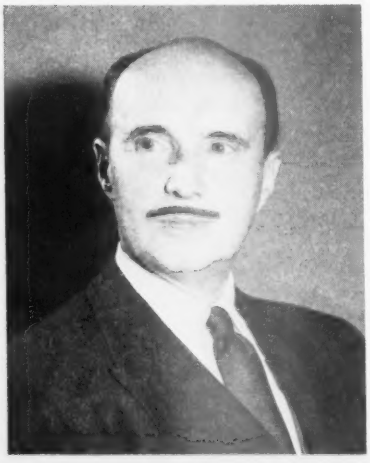
David E. Culnan (M) has joined the General Electric Company at Syracuse, N.Y., as an Engineer on a Special Radar Project. He formerly was a Research Engineer at Boeing Airplane Company.

George E. Fouch (M), former General Manager of General Electric Company's Evendale Operating Department, Aircraft Gas Turbine Division, has been appointed a Marketing Consultant in the firm's Marketing Services.

Theodore D. Gottlieb (TM), who was Design Specialist in the Pneumatics Division of Hydro-Aire, Inc., has joined United Atomics, Inc., as Chief Design Engineer.

George T. Hayes (TM), former Manager of Stanford Research Institute's Washington, D.C., office, has been appointed Assistant Director of the Institute's Physical Sciences Division in Menlo Park, Calif. Mr. Hayes is Secretary of the IAS Washington Section.

Bela K. Erdoss (M), former Professor of Fluid Dynamics and Director of the Fluid Dynamics Laboratory at Stevens Institute of Technology, has been elected President of The Korfund Company, Inc., manufacturer of vibration, shock, and noise-control products.



Rudolph W. Hensel (M) has been appointed Chief of the Propulsion Wind Tunnel at ARO, Inc., contractor for the USAF's Arnold Engineering Development Center, Tullahoma, Tenn. He was Assistant Chief before being promoted.

Richard A. Hirsch (M) has been made Chief Aerodynamics and Structures Engineer at Aircraft Armaments, Inc. He formerly was responsible for structural and design research and development programs in the Aerodynamics and Structures Department.

Marvin J. Kahn (M), former Chief Aerodynamics and Structures Engineer for Aircraft Armaments, Inc., has been appointed Assistant Director of Engineering.

Philip M. Klauber, Chief Administrative Engineer, Solar Aircraft Company, has been named Chairman of the San Diego Section of the Society of Automotive Engineers.

Don McLaren (M), former Research Engineer with Continental Aviation & Engineering, Detroit, has joined Chance Vought Aircraft, Incorporated, Dallas, Tex., as Senior Engineer, Propulsion Section.

Charles W. Miller (M), former Engineering Specialist with Northrop Aircraft, Inc., has joined The Ramo-Wooldridge Corp. as a member of the Technical Staff.

Jack S. Parker (M), General Manager of General Electric Company's Aircraft Gas Turbine Division, has been elected a Vice-President of the firm.

Joseph J. Sheppard, Jr. (TM), formerly Senior Engineer, Rosemount Aeronautical Laboratory, has joined Convair, A Division of General Dynamics Corporation, as Staff Scientist in the firm's Scientific Research Laboratory.

Louis J. Walkover (M) has been promoted to Supervisor, Preliminary Design Group of the Advanced Engineering Department, Missile Development Division, at North American Aviation, Inc. He formerly was a Specialist in this department.

E. W. C. Wilkins (AF), former Technical Assistant—Aircraft Fatigue for the Royal Aeronautical Society, London, has joined the California Division of Lockheed Aircraft Corporation as Research Specialist.

Attention Members!

All Members of the Institute are invited to submit material concerning their activities for publication in the news columns of the *Aeronautical Engineering Review.*

B. F. Goodrich brakes, wheels and tires selected by Temco for new jet trainer

In designing the new TT-1 primary jet trainer for the Navy, Temco engineers asked for a high capacity brake that would take the punishment of a trainer's high landing frequency. And they wanted wheels and tires that would stand up to the strain when student pilots make "six landings to the approach".

For these reasons they selected a complete B. F. Goodrich package, wheels, brakes and tires. Dynamometer and actual flight tests prove that B. F. Goodrich disc-type brakes have greater capacity for fast, chatter-free stops than any brakes on the market today.

Full 360° sintered metal linings give longer brake life and better ground control. An automatic 2-way adjuster maintains constant lining clearance regardless of service wear, eliminates periodic manual adjustment and assures that the brake will always react the same way to pedal pressure.

B. F. Goodrich brakes, wheels and tires combine unusual strength with minimum weight. These features give the country's newest military training plane added safety for take-off, landing and for ground control, too.

ENGINEERS AND DRAFTSMEN
For interesting and rewarding assignments in developing a variety of new products for aviation, contact: Technical Superintendent, B. F. Goodrich Aviation Products, Troy, Ohio. Your inquiry will be confidential.

B.F.Goodrich Aviation Products

a division of The B. F. Goodrich Company, Akron, Ohio

Tires • Wheels • Brakes • De-Icers • Inflatable seals • Fuel cells • Heated Rubber Pressure Sealing Zippers • Rivnuts • Avtrim • Adhesives • Hose and rubber accessories

CORPORATE MEMBER NEWS

• **Aerophysics Development Corporation** . . . The firm's Chief of Structures, Adam T. Zahorski, has been invited to present a set of lectures on "Structures Considerations in Aircraft Research" at the University of California at Los Angeles.

• **Airborne Accessories Corporation** has introduced a new line of radio frequency filters and starting capacitors which the firm says are smaller and more efficient than any available on the market.

• **Allis-Chalmers Manufacturing Company** is producing a new type of axial compressor with full stator blade control for extended range of operation and high frequency.

• **American Airlines, Inc.,** has announced that DC-7 service will be extended to nine new areas including Chicago, San Francisco, Dallas, Fort Worth, Phoenix, Tucson, Detroit, Boston, and Cincinnati. . . . John H. Mahoney, formerly Assistant Director, Tariffs and Schedules, has been appointed Director of Traffic.

• **Avien, Inc.,** has appointed Monroe A. Maller to the position of Marketing Manager. He will take over the post of William O. Boschen who becomes Assistant General Manager and Director of Engineering. Before his promotion Mr. Maller was Vice-President and General Manager of the firm's West Coast subsidiary, Avien Service Corporation of California.

• **Beech Aircraft Corporation** has announced that its commercial sales have reached a high of $40 million for 1956.

• **Bell Aircraft Corporation** has announced the following promotions, appointments, and assignments: Harvey Gaylord, General Manager of the Texas Division to President of Bell Helicopter Corporation subsidiary; Francis W. Dunn, Director of Public Relations to Assistant to the President for Public Relations and Public Affairs; named to Rockets Division posts are Floyd H. Walters, Director of Manufacturing; R. Dewey Rinehart, Director of Engineering; Harry A. Ferullo, Director of Programs; Stephen D. Krull, Director of Tests; Joseph H. Piselli, Manager of Customer Relations and Sales; and Melvin J. Blessing, Manager of Contract Administration.

• **Bendix Aviation Corporation . . .** Pacific Division has developed a semiautomatic programed test set with digital printed read-out for use in final testing missile telemetering packages. . . . Pioneer Central Division has been cited for industrial safety achievement. . . . Donald C. McDonald has been appointed to a new position of Director of Engineering by the Friez Instrument Division.

• **Boeing Airplane Company . . .** Transport Division has announced the appointment of Bernard Duperier to the post of Consultant. Mr. Duperier, whose office is in Paris, is the Grand Officer of the Légion d'Honneur Compagnon de la Libération.

• **Bristol Aero Engines Limited** has announced that Finland is the seventh country to order the Folland Gnat light fighter powered by its Orpheus engine. Finland also has ordered spare engines.

• **Eastern Airlines, Inc.,** has put a combined fleet of 166 multiengined aircraft on its Florida run for winter vacationers.

• **Edo Corporation** has developed a new air-borne loran receiver for installation in aircraft. The lightweight unit is designated Edo Airborne Loran (Model 345) and features cockpit installation and display under pilot control.

• **Fairchild Engine and Airplane Corporation** announced that Aerovias Ecuartorianas is the first South American air line to order the Fairchild F-27.

• **Federal Telecommunication Laboratories, Division of International Telephone and Telegraph Corporation,** has announced that an operating staff nucleus of 14 members has begun working at the firm's new Palo Alto facility.

• **The Garrett Corporation,** AiResearch Manufacturing Co. division, has developed an electrical actuator that reportedly trims pitch of helicopter blades in 4 sec., taking over work previously performed by a manually adjusted turnbuckle. The actuator will be installed in the Bell XH-40 turbine-powered helicopter. Adjustment of blade pitch can be made by the pilot during flight or on the ground. . . . Ralph Matthews, Jr., former Chief Pilot for Sawhill Tubular Products, Inc., has joined AiResearch Aviation Service Co. division as a member of the sales staff. Harrison W. Holzapfel was made Assistant Manager of this division after he was transferred from the manufacturing division Engineering Staff.

• **General Dynamics Corporation . . .** Canadair Limited (subsidiary) announced the sale of 225 Canadair Sabre VI jets to the Republic of West Germany for $75 million. The sale includes provision for training 360 German pilots by the Royal Canadian Air Force. Canadair's first CL-28, a piston-engine military evolution of the Bristol Britannia, has been completed. The firm reports it is the largest aircraft ever built in Canada. Paul Falconer, former test pilot for Bristol Aircraft Company in England, has joined the Canadair Flying Staff. . . . Convair Division's F-106A all-weather jet interceptor has had its first test flight at Edwards Air Force Base. At Convair's Fort Worth plant a B-58 preflight training program for USAF pilots and observers has begun. H. C. Deckhard, Executive Staff Assistant to Convair Vice-President and Manager August C. Esenwein, has retired.

• **General Electric Company . . .** Apparatus Sales Division: An ultra-fine particle iron magnet, reported to be theoretically ten times stronger than the best available magnets, has been developed by the Instrument Department Measurements Laboratory headed by T. O. Paine. The magnet is made of ordinary iron in the form of submicroscopic elongated particles. By "stretching" round iron particles to elongated shapes, a high resistance to demagnetization was achieved. Dr. Paine said the magnetic and mechanical properties of this material can be controlled precisely. In application the new magnet will result in electric instruments that are smaller, lighter, more accurate, and more rugged. Also, the iron particles can be imbedded in plastic, metal, rubber, or glass. . . . The Distribution Assemblies Department has announced a new plug-in type of busway with low-voltage-drop characteristics. The department also reports development of a new hinged-cover wireway, with each length and fitting accessible for lay-in wiring, and a new heavy-duty, column-type lighting panelboard, designed for four-wire, 480Y/277-volt service. . . . Chemical & Metallurgical Division: The Metallurgical Products Department, Edmore, Mich., plant has been redesignated the Magnetic Materials Section. The department has completed a new Eastern carbide metals shop in Kenilworth, N.J., to process small quantities of specially shaped cemented carbide tools. . . . John B. Montgomery, a former commanding general of the U.S. Eighth Air Force, has been appointed General Manager of the Production Engine Department of the Aircraft Gas Turbine Division. . . . Electronic Components Division has announced that it will convert its Buffalo TV picture tube plant to the manufacture of transistors. It will also cut prices of 15 transistor models about 46 per cent lower than 1956 prices. . . . Defense Electronics Division has established two new operating sections in the Missile and Ordnance Systems Department—the Nose Cone Section and Ordnance Section. . . . Industrial Electronics Division has announced a new line of nonsynchronous resistance welding control panels.

• **General Precision Equipment Corporation. . . .** Link Aviation, Inc., has received an order for the first Lockheed Electra turboprop flight simulator from KLM Royal Dutch Airlines. KLM also ordered a simulator for the Douglas DC-8. The first of two trailerized simulators for the Grumman F11F-1 Tiger has been delivered to the Navy. The firm also is building simulators for the Air Force F-102 and F-106 interceptors.

• **G. M. Giannini & Co., Inc.,** has developed a high-temperature, infinite resolution potentiometer that has been added to its Spiralpot line of slide-wire type precision potentiometers; designation is 85177A. The firm also has announced the Model 8915 Rotostepper, an electromechanical shaft positioning device which provides controlled incremental shaft rotation of one 2-deg. step per d.c. pulse.

• **B. F. Goodrich Company** has announced the following appointments in its Aviation Products Division: Donald Starner, Manager of Sales and General Accounting; Carl J. Tsaloff, Akron Plant Manager; Louis J. Fulop, Manager of De-Icer and Rivnut Sales; and Glenn A. Zimmerman, Manager of New Products Sales.

• **The Goodyear Tire & Rubber Company, Inc.,** has developed a specially com-

THERMOCOUPLES TAKE JET'S TEMPERATURE

Fenwal Harness Is Foolproof, Has Long Life

ASHLAND, MASS. — One mechanic who'd never seen Fenwal's Jet Engine Harness before installed it properly in fifteen minutes.

A fool would need a few minutes more to do the trick, but he'd have to be an idiot to get it on wrong. Fenwal makes the harness, which senses a jet's exhaust temperature with thermocouples, as simple as it can possibly be. It can be used for indication, control, or, with certain inexpensive modifications, for both.

The service-life of the harness is at least hundreds of hours in excess of Government specifications. The actual life can only be given as more than a thousand hours, since field tests were called off at that point, with absolutely no signs of failure apparent.

Fenwal pre-forms the harness to fit your engine, and the installer simply slips it around the tail cone. Only two bolts for each thermocouple lock the thermocouple to the harness and the harness to the mounting boss. All thermocouples are keyed, so that they can be installed only in the proper way.

Terminal studs have been eliminated — and vibration-induced breakage and short circuiting have been eliminated too. In place of studs are curved buttons on the thermocouples and flat buttons on the harness. These buttons make the contact between the thermocouple and the harness.

As for maintenance, nothing could be simpler. If it ever becomes necessary to replace a thermocouple, only two bolts are involved. Since the contact buttons are exposed to air flow, removal of moisture and foreign particles from them is virtually automatic. The harness itself needs no care, since it is sheathed in stainless steel, and the bus bars are insulated with a special hard asbestos.

RELIABLE AND FOOLPROOF — This Fenwal Jet Engine Harness senses jet engine temperatures with interchangeable thermocouples for indication and control purposes. It is exceedingly simple to install. It has been service tested for 1000 hours without failures.

You don't have to worry about the effects of differential expansion on the harness, either. The assembly is semi-flexible, and puts only light stresses on the bosses. The bosses don't have to be "beefed up."

The system performs at ambient temperatures up to 1200°F, and Fenwal is prepared to make systems for higher temperatures on request.

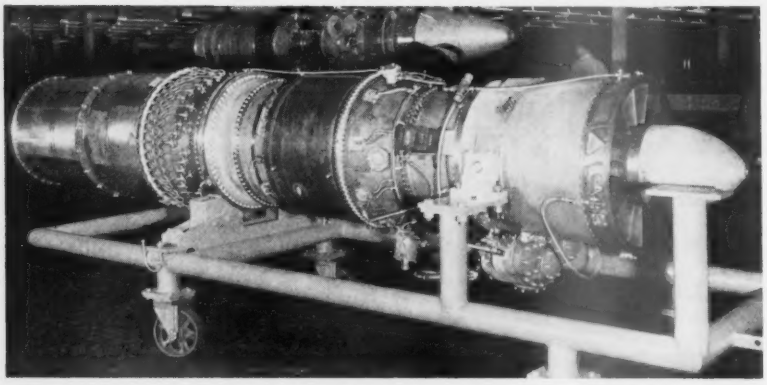
It is remarkably light. A four-thermocouple system with a 21-inch diameter harness, for instance, weighs only 3.6 pounds, bolts and all.

You will have no trouble integrating the system with your own indicator or control schemes, or both. The circuitry is simple, too, with balancing resistors in the thermocouple mounting pads for maximum control accuracy. Tolerances are such that no adjustments are needed when a thermocouple is replaced.

Contact your local Fenwal Sales Engineer, or write to Fenwal direct to learn how this system and other widely useful Fenwal concepts can solve temperature control problems now facing you. **Fenwal Incorporated, Aviation Products Division, 172 Pleasant Street, Ashland, Mass.**

Fenwal

CONTROLS TEMPERATURE
...PRECISELY



Pratt & Whitney Aircraft Division of United Aircraft Corporation pictures for the first time its new, medium-sized J-52 jet-turbine engine, which will be installed in current production models of the Douglas A4D Skyhawk. Design was under the auspices of the Navy's Bureau of Aeronautics to meet power-plant requirements of a variety of new naval aircraft, including a supersonic trainer, a small, high-speed fighter, and an attack aircraft. Performance specifications are classified.

pounded tubeless tire for operation in Arctic cold.

• **Jack & Heintz, Inc.,** has announced the election of Carl F. Herbold and Ralph J. Eschborn as Vice-Presidents. Mr. Herbold formerly was Assistant to the President, Mr. Eschborn was Chief Engineer.

• **Walter Kidde & Company, Inc.,** has issued a publication describing and illustrating the operation of the firm's new combined fire and overheat detector for aircraft.

• **Lockheed Aircraft Corporation's** Georgia Division reports the largest skis ever made for aircraft are being fitted on the C-130 Hercules for operation in the Arctic and Antarctic regions. Engineers at the Marietta plant are preparing four other new versions of the Hercules—a tanker, photo, command, and improved (C-130B) version. Former British aircraft engineer Gordon Forbes has been promoted from Senior Flight Test Engineer to Department Engineer in Flight Test Engineering. . . . Missile Systems Division is planning to acquire a 4,000-acre mountain site near Santa Cruz, Calif., for development testing and research on new and advanced missile systems and components. Some 200 scientists attended a symposium on magneto-hydrodynamics at the division laboratories in Palo Alto, Calif.

• **Manning, Maxwell & Moore, Inc.,** Aircraft Products Division, has announced a Type 6576 High-Temperature Pressure Switch of all-welded stainless steel construction, reported to operate at a rated 650°F. The switch has a snap-action element and a precision stacked-capsule sensing element.

• **Marquardt Aircraft Company** has been designated as a prime contractor in the USAF Aircraft Nuclear Propulsion program. The company is currently engaged in ANP studies.

• **Minneapolis-Honeywell Regulator Company . . .** Steven E. Puffer, formerly Assistant Director of Procurement for the Aeronautical Division, has been appointed Director of Procurement at the division's inertial guidance engineering plant now under construction near St. Petersburg, Fla.

• **Norden-Ketay Corporation** has signed a lease for a new plant to be built as an extension to the Commack plant of the Precision Components Division, near Jericho Turnpike, L.I. New bulletin #410 describes high-temperature servomechanism components which are available to meet customer specifications. Bulletin #403A lists specifications and characteristics of new pressure gages. Both are available from Justin Oppenheim, Norden-Ketay Corporation, Commerce Road, Stamford, Conn.

• **North American Aviation, Inc.,** has delivered the last production model F-86 Sabre Jet to the Air Force. More than 6,000 were produced by the firm. . . . Manufacturing equipment and machinery are being moved into the factory area of the Government-owned rocket-engine facility at Neosho, Mo., as the first step in the operation of the plant by Rocketdyne Division. . . . Autonetics Division has been elected to membership in the Radio Technical Commission for Aeronautics.

• **Northrop Aircraft, Inc.,** reports that the first phase of Project Sniff, an intensive study of the effect of wind gusts on low-flying supersonic aircraft, has been completed. The firm also reports a record of 1,617.40 flying hours in 1 month established for its Scorpion F-89D at Moody AFB, Georgia. A new high-speed target-tow reel system called the Bee-Jay for use in gunnery and rocketry training with supersonic fighters has been developed jointly with the USAF. F. W. Lloyd and G. C. Chalmers have been appointed Manager and Assistant Manager of Manufacturing Engineering. Morris Plotkin has been named Assistant Director of Facilities Planning.

• **Nuclear Development Corporation of America** reports it has been selected by the Centre d'Études pour les applications de l'Énergie Nucléaire (CEAN) of Belgium to design and develop an engineering test reactor of advanced concept. CEAN is jointly sponsored by the Belgian government, industry, and universities to expand the applications of atomic energy.

• **Republic Aviation Corporation** has announced the approval of a technical assistance contract between Republic Aviation International and the Weser Aircraft Company of Germany by the United States and West German governments. Republic will supply activation and maintenance assistance for its F-84F and RF-84F aircraft, used by the West German Air Force. A special engineering employment section has formed with George R. Hickman as Technical Employment Manager and Kenneth D. Baldwin as Assistant Manager.

• **Ryan Aeronautical Company** has announced the appointment of Victor A. Camfield, Jr., to the post of Dayton Representative. He formerly was a civilian official in the USAF Air Materiel Command.

• **Solar Aircraft Company's** Des Moines plant is using specially designed and built tumbling machines to smooth the edges of large precision assemblies. The firm reports that the finishing operation on the engine assemblies has been cut to one quarter of the time previously required. Donald M. McGrath has been named San Diego Plant Manager.

• **Thompson Products, Inc.,** has announced the appointment of Gen. Benjamin W. Childlaw, USAF (Ret.), as Chairman of the firm's Planning Committee. G. R. Moore has been appointed Vice-President—Sales and Advertising.

• **Vertol Aircraft Corporation** has announced conclusion of an agreement with Shin-Meiwa Industry Co., Ltd., of Tokyo, to maintain and overhaul Vertol helicopters in the Far East.

• **Western Gear Corporation . . .** Electro Products Division has announced a new transistorized d.c. voltage regulator in two models of varying current capacities.

• **Westinghouse Electric Corporation . . .** Air Arm Division has developed a special turntable for field testing gyroscopes used in planes aboard aircraft carriers. A d'Arsonval torquemotor is being used in a miniature gyroscope specially designed for fire-control systems. The torquemotor is one of four fundamental components; others are a gyroscope spin-motor, position detector, and a damper. Engineers have placed a thin protective aluminum "skin" $2^1/_2$ mils thick on copper wire in the Materials Engineering Department. The process is reported to increase life, reduce size, and raise efficiency of electrical equipment by allowing it to operate over longer periods of time at higher temperatures.

Change of Address

Please notify the Institute of the Aeronautical Sciences, 2 E. 64th St., New York 21, N.Y., when you change your mailing address.

Notification of the change should be received 30 days in advance of publishing date to ensure receipt of every issue of the *Journal* and *Review*.

PIONEERING SCIENTIFIC FRONTIERS AT GENERAL MILLS

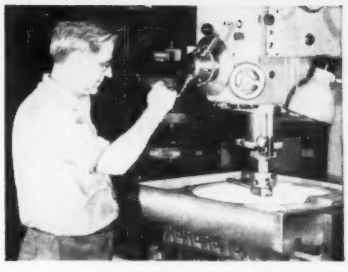
Dr. J. E. Barkley, director of research, takes a reading in the dark tunnel during study of new infrared techniques being conducted by the Mechanical Division of General Mills.

What else can infrared do?

Infrared detection devices have become almost commonplace. These invisible rays are now used in photography and several other industrial and military applications. But the full capabilities of infrared have not yet been determined. Dr. Barkley and his staff, working from an extensive background in current uses of infrared, are researching several possible applications right now.

These studies in basic infrared technology represent but a single phase of General Mills' over-all program of advanced exploration in theoretical and developmental physics, electronics and mechanical design.

Findings in this "research for tomorrow" are being translated regularly into practical applications for industrial and military use today. If you have product or production problems, you can profit from these applications, and from our high-level production facilities.



CAN YOU BENEFIT FROM HIS SKILL AND EXPERIENCE?

Skilled craftsmen, who are as proud of the precision products they produce as they are of the highly specialized machines they use, work with exacting care which comes only from many years of experience. Mass production and on time delivery of electro-mechanical and mechanical devices is routine at General Mills.

Send for Production Facts New booklet shows our facilities, names our customers—introduces you to on time, precision manufacturing. Write Mechanical Division, Dept. AR-3, General Mills, 1620 Central Ave. N. E., Minneapolis, Minn.

MECHANICAL DIVISION

CREATIVE RESEARCH AND DEVELOPMENT — PRECISION ENGINEERING AND PRODUCTION

General Mills

IAS SECTIONS

Atlanta Section

Frederick A. Alden, III, Product Utilization Engineer on the Vanguard Project, discussed the satellite program before 108 members and guests at the December 6 meeting at the Atlanta Naval Air Station.

Mr. Alden described physical characteristics of the three-stage missile which will house the spherical satellite in a nose cone. The unit is 72 ft. long and has a maximum diameter of 45 in. At launching it will weigh about 22,600 lbs., he said.

A unique feature is the lack of aerodynamic stabilization fins. Attitude and roll control will be by gimballed rocket motors and a series of jets.

First stage will be propelled by a General Electric Company designed rocket motor burning liquid oxygen and kerosene. This fuel will be delivered by turbine pumps, driven by a high-concentrate hydrogen peroxide "steam" which also will supply thrust to roll control jets.

The second-stage rocket motor is being developed by Aerojet-General Corporation. It will contain a three-axis autopilot to control the gimballed motors and roll jets in both the first and second stages. The third-stage motor has not been selected yet, he said.

The first stage will carry the unit to an altitude of about 35 miles at a velocity of 3,700 ft. per sec. The first stage will separate from the unit when fuel is burned out. The second stage will carry the unit 130 miles at 13,500 ft. per sec. and also will separate. After a coasting period the third stage will drive the unit 300 miles at 17,500 ft. per sec. At this altitude the satellite will separate and establish its orbit. The third-stage rocket also is expected to form an orbit.

The elliptical orbital path will have a perigee distance of about 300 miles and an apogee distance of about 1,400 miles, depending upon altitude, velocity, and attitude achieved during the launching.

The orbit will allow the satellite to be visible from most of the temperate zone of the world. How long the satellite will be in its orbit depends upon the air density at its objective altitude. It may vary from a few days to several months. No attempt at recovery is being considered.

Mr. Alden concluded by showing a film on the Viking research rocket made by The Glenn L. Martin Company. Design, manufacture, and launching were featured.

CLAUD V. WILLIAMS, *Secretary*

Baltimore Section

A lecture on "Transition From Laminar to Turbulent Boundary Layers at High Speeds" was delivered by Mark V. Morkovin at the December 11 specialist meeting at The Johns Hopkins University. Dr. Morkovin is Research Scientist and a Lecturer at the university.

He described the causes, character, and magnitude of turbulence phenomena, using an electrical simile of a black box with variable inputs and outputs. He demonstrated factors affecting transition flow in a manner that was descriptive rather than mathematical.

Members engaged in a discussion period after the talk.

RICHARD W. SANFORD, *Chairman*

Boston Section

One of the largest crowds to assemble recently at a regular session of this Section met at the Wayland Laboratory of the Raytheon Manufacturing Company on December 4 to hear David W. Whitcomb of Cornell Aeronautical Laboratory, Inc., speak on "Automobile Stability and Control (As Seen by the Aeronautical Engineer)."

Mr. Whitcomb, just back from England where he gave this talk at the British Institution of Mechanical Engineers, explained how the commonly accepted aircraft stability analysis techniques have been applied to the study of automobile static and dynamic lateral stability.

Performed at Cornell under a General Motors contract, the study will be used to develop a theory of vehicle lateral stability for design purposes. Significant parameters will be determined to predict response of a vehicle to control imputs (those induced at the wheel) or to external disturbances (wind and road imputs).

The automobile was described by much the same axis system used in aircraft stability analyses. Analogy between the tire and airfoil was made, showing how tire slip-angle produces lift in the same fashion as angle-of-attack on the airfoil. Conventional stability derivatives, as well as several new derivatives peculiar to the automobile, were established after computing "lift and moment curves" for the tire. Equations of motion were written and nondimensionalized, and it was pointed out that the concept of a neutral (steer) point and static margin can also be defined for the automobile.

Mr. Whitcomb showed results of static stability analyses which introduced the terms "understeer" and "oversteer" and illustrated how there is a loss in yaw damping with an increase in speed of the conventional automobile. He said best performance might be attained by a car with a long wheel base and stiff tires.

Dynamic stability investigations produced roots for the yaw and sideslip modes which described damped exponential motion, but as the speeds increase the motion becomes oscillatory and the damping decreases for the automobile with positive static margin. Finally, the conventional automobile was compared with the racing car, and it was shown that the racing car is much more stable at high speeds, primarily because of its low static margin and stiffer tires.

A lively discussion took place after Mr. Whitcomb's talk.

DANIEL J. FINK, *Secretary*

Chicago Section

More than 100 members and guests heard A. M. "Tex" Johnston, Boeing Airplane Company's Chief of Flight Test, discuss the firm's 707 jet transport on December 5.

Mr. Johnston traced the development of the design by means of operating information gathered from thousands of hours of flying experience with B-47 and B-52 aircraft. He outlined design of jet "pods" and spacing to restrict spanwise flow, design premise for selecting tricycle landing gear and basic design premise of the lateral control system.

Flight and operating characteristics were described. Mr. Johnston said the 707 can operate in the same traffic pattern and at the same air speed used by current air liners. However, the 707 can operate at roughly twice the utilization factor of comparable propeller transport aircraft. Flight time for the jet from New York to London or Paris is slightly more than 7 hours, and from coast-to-coast about 5 hours.

Mr. Johnston showed movies of the 707 flight-test program. He also discussed airport noise problems expected with jet operation and the research programs under way to combat the problems.

R. F. HUNTER, *Secretary*

Hagerstown Section

"Operational Testing of the C-123B" was discussed by Capt. Ralph Blackwell, USAF, at the December 11 meeting. Captain Blackwell is in charge of operational testing of this aircraft at Eglin Air Force Base.

He described preparation for testing and actual flight testing. This included training a crew in maximum performance takeoffs and landings on hard-surfaced fields. Later tests were performed on unimproved and unprepared fields.

The aircraft was tested for 4 months during which time aeromedical, troop transport, paratrooper, aerial resupply, and equipment transport capabilities were determined. Arctic tests also were undertaken.

Captain Blackwell explained the mission and operations of the Air Proving Ground Command. After the talk, members engaged in a question-and-answer period.

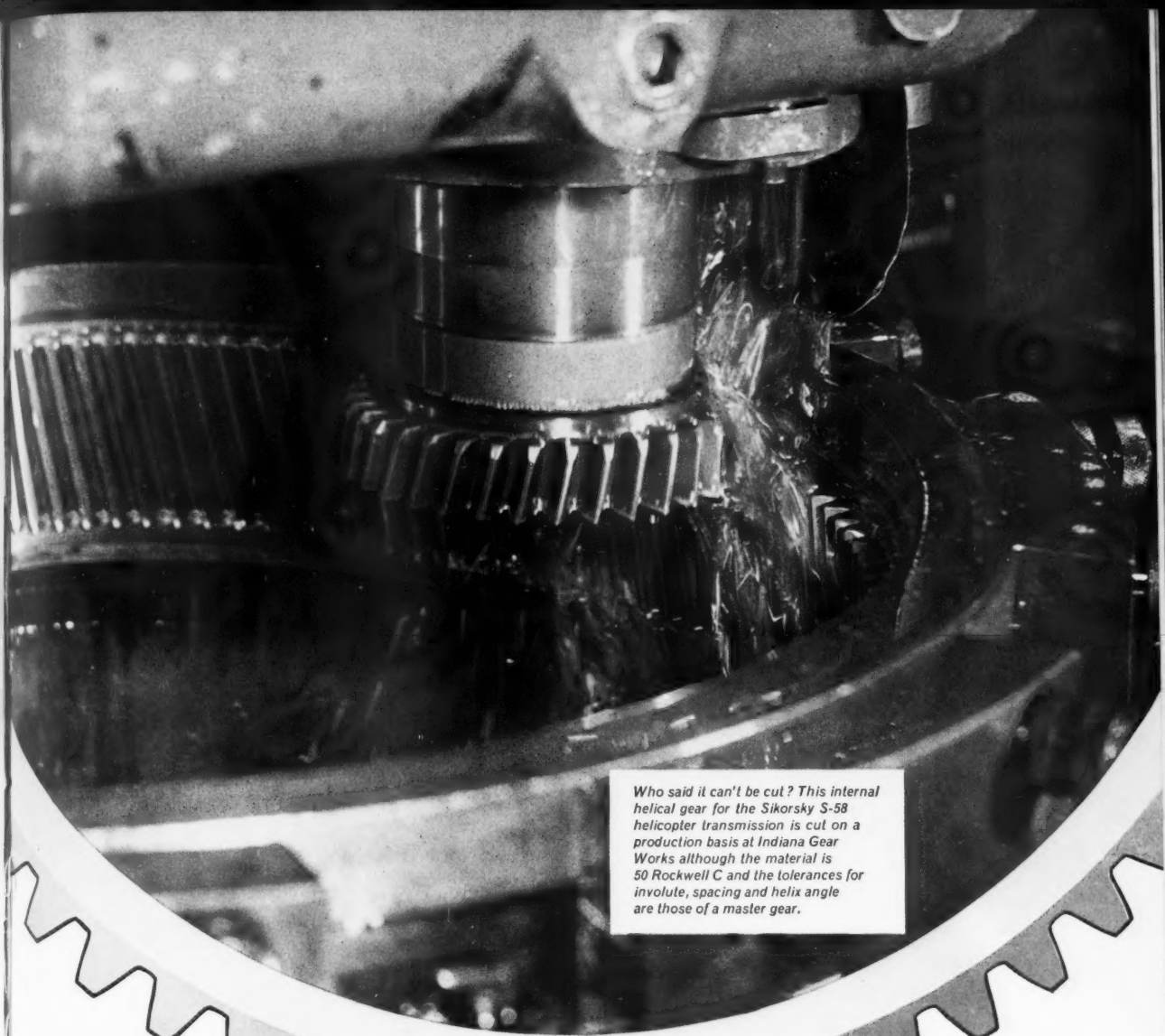
James F. "Skeets" Coleman, first pilot to fly the Navy's XFY-1 Pogo VTO fighter, spoke on "Vertical Riser—Engineering Test Pilot's Report" at the November 20 meeting.

He stressed the fact that STOL and VTOL aircraft are not new from the designer's point of view. He showed a movie of the aircraft making landings and take-offs. Some 40 members engaged in discussion after the talk.

R. W. BRADHAM, *Secretary*

Hampton Roads Section

Members of the Section were joined by members of the Engineers Club of the



Who said it can't be cut? This internal helical gear for the Sikorsky S-58 helicopter transmission is cut on a production basis at Indiana Gear Works although the material is 50 Rockwell C and the tolerances for involute, spacing and helix angle are those of a master gear.

PRECISION
is Our *Only* Product!

● Everything at I.G.W. is geared to precision. You'll find a "feeling" for precision not just in inspection and production and engineering, but also in maintenance and shipping and on throughout the company. It's the basic reason why I.G.W. is *the* recognized source for precision gears

INDIANA GEAR WORKS, INC.

INDIANAPOLIS 7, INDIANA

"NIGHT CHESS" a painting by Simpson-Middleman, a doubly gifted team of artists with a scientist's penetrating insight. They portray here "a chess-like game played in a segment of space on a skewed board with pieces of uncertain value against an unknown antagonist. The next move is unforeseen—it will come out of the dark—it will be history's most fateful gambit."

High stakes are yours to win at Boeing

Your future comes quickly at Boeing . . . for the future is Boeing's business. There is no reverence here for "limits"—creative engineers are exploring exciting pathways into the unknown.

Here, the jet age has already begun in air travel. America's first jet liner, the giant Boeing 707, has been test flying for over 2 years.

Because Boeing is already looking beyond this and other "tomorrows," still searching more distant horizons, we need you.

We welcome all types of engineers and scientists and advanced mathematicians who enjoy the excitement of being far ahead in the vaster vistas of supersonic flight, of electronic guidance, in virtually every field associated with flight.

It is a stimulating experience. And in this sympathetic climate, you'll find very quickly that "you belong . . . at Boeing."

Drop a note now to John C. Sanders, Engineering Personnel Administrator, Boeing Airplane Company, Department A-61, Seattle 24, Washington.

BOEING

Virginia Peninsula to hear J. Gordon Bennett on "Aviation Facilities Planning" at the December 5 meeting.

Mr. Bennett is Executive Assistant and Acting Deputy to Edward P. Curtis, Special Assistant to the President for Aviation Facilities Planning. He discussed the organization of this office and reported on progress to date.

He said his office has three tasks: The direction and coordination of a long-range study of national requirements for aviation facilities; development of a comprehensive plan for meeting needs in the most effective and economical manner; and formulation of legislative, organizational, administrative, and budgetary recommendations to implement the plan.

The office has obtained the combined services of the Airborne Instruments Laboratory, the Cornell Aeronautical Laboratory, and the Aeronautical Research Foundation to determine long-range requirements.

For the second phase, the office has organized a Systems Engineering Team made up of eleven of the best scientific and practical men available. Their first job has been a thorough study of current traffic control centers and towers. They have observed pilot problems first-hand by riding in the cockpit and have taken an abbreviated controller course at the CAA's Oklahoma City center.

The team also has examined many proposals put forward for new systems. These include proposals from industry, the military, and the CAA.

Third-phase activities include tracing the evolution of current Government organizations and committees, both civil and military, which are concerned with common aviation facilities. The team has sought to know why such groups were formed, what they have accomplished, and if they have failed to attain their objectives.

Mr. Bennett said his office hopes to have recommendations ready for the President this spring.

RICHARD T. WHITCOMB
Recording Secretary

Rocky Mountain Section

First winter meeting was held October 19 at Lowry AFB Officers Club in Denver. Stanley Aviation Corporation, acting as sponsor, organized a panel discussion on the operation of turbojet and turboprop transports. Panel members were Robert Stanley, President of the Stanley firm, who acted as moderator; Don Wilson, Assistant to the Vice-President of Continental Air Lines, Inc.; and I. F. "Gus" Sommermeyer, Director of Flight Operations, United Air Lines, Inc.

More than 100 persons at the dinner and regular meeting heard the following slate of officers elected for the year:

Chairman, Allison Arnold of Stanley; Vice-Chairman, Col. Paul Dane, Air Force Academy; O. T. Larsen, United Air Lines; Lawrence Soderberg, Beech Aircraft Corporation's Engineering Facility; C. E. Waddell, and F. P. Durham, both of the University of Colorado.

Mr. Stanley began the panel discussion by recalling Frank Whittle's prediction in 1943 that, within 3 years, jet airplanes would replace piston-engine planes. Mr. Stanley posed a series of questions to Mr. Sommermeyer and Mr. Wilson, who brought out the following points.

Anticipated cruising speed of jet transport planes will be roughly double that of piston-engine planes, permitting a flight from Denver to New York in about 3 hours and 15 min. Operating altitudes will be higher than for piston planes, about 40,000 ft. for long hauls. At this altitude, speed limits for both Boeing 707 and Douglas DC-8 will be approximately Mach 0.88. Turbojets will be more than 100 m.p.h. faster than turboprops.

Air lines will face major changes in ground handling problems to cope with jet blast and noise effects. Also, jets will greatly reduce in-flight time required between operating points, the time required for ground servicing and cargo handling. One proposal under consideration to improve cargo handling is the so-called increment loading of preloaded pods into the cargo compartment.

Both Boeing and Douglas are working on jet silencers, jet blast reduction, and thrust reverse mechanisms. The problem here is to make the thrust reverser and noise suppressor systems work well together. Rolls-Royce in England has been a pioneer in this field.

With both systems operating, it is predicted that the noise pattern around the 707 will be like that around the DC-6 and 7. A noise drop of 18 to 20 db. is desired, but currently only a 12- to 14-db. drop is being attained.

Acceleration characteristics and increased gross loads may mean a 30 per cent increase in normal runways.

On the economy side, the concensus was that cost-per-seat-mile will either remain the same or drop for jets although depreciation, a major factor, is difficult to estimate. No increase in fares is anticipated. Air lines are making long-range studies on problems of handling passengers and baggage from the point of view of reservations and loading. Data processing equipment is expected to facilitate ticket and reservation procedure.

In answer to a question on why air lines were buying so many larger planes and whether this is economically feasible, it was said future cuts in fare for long hauls should pick up more passengers. New jets will be in use for a long time, otherwise air lines will not get satisfactory utilization from them. As a result, they are being built to carry loads expected 10 years into the future. Larger fuel capacity also requires a larger plane.

Current traffic control systems were said to be inadequate for jets. However, the development of automatic systems for handling traffic may solve the problem. These systems are in pilot model tests now.

A 100-mile interval is needed for pilots to report in, but jets, with their increased speeds, may need a 200-mile interval. Hope was voiced that radar control of air space will be attained by 1962. No specific changes are expected in holding patterns, fuel reserve requirements, or flight weather minimums.

SAC experience was cited to show that jet and turboprop engines are more reliable than piston engines. Engine problems in a given period of time number five for pistons to one for jets, but jet air frames are expected to be more trouble than piston craft air frames.

Better pressurization systems are presumed for jets because loss of pressure at 40,000 ft. would not be tolerable.

Passenger comfort will be improved from standpoints of sound level and vibration.

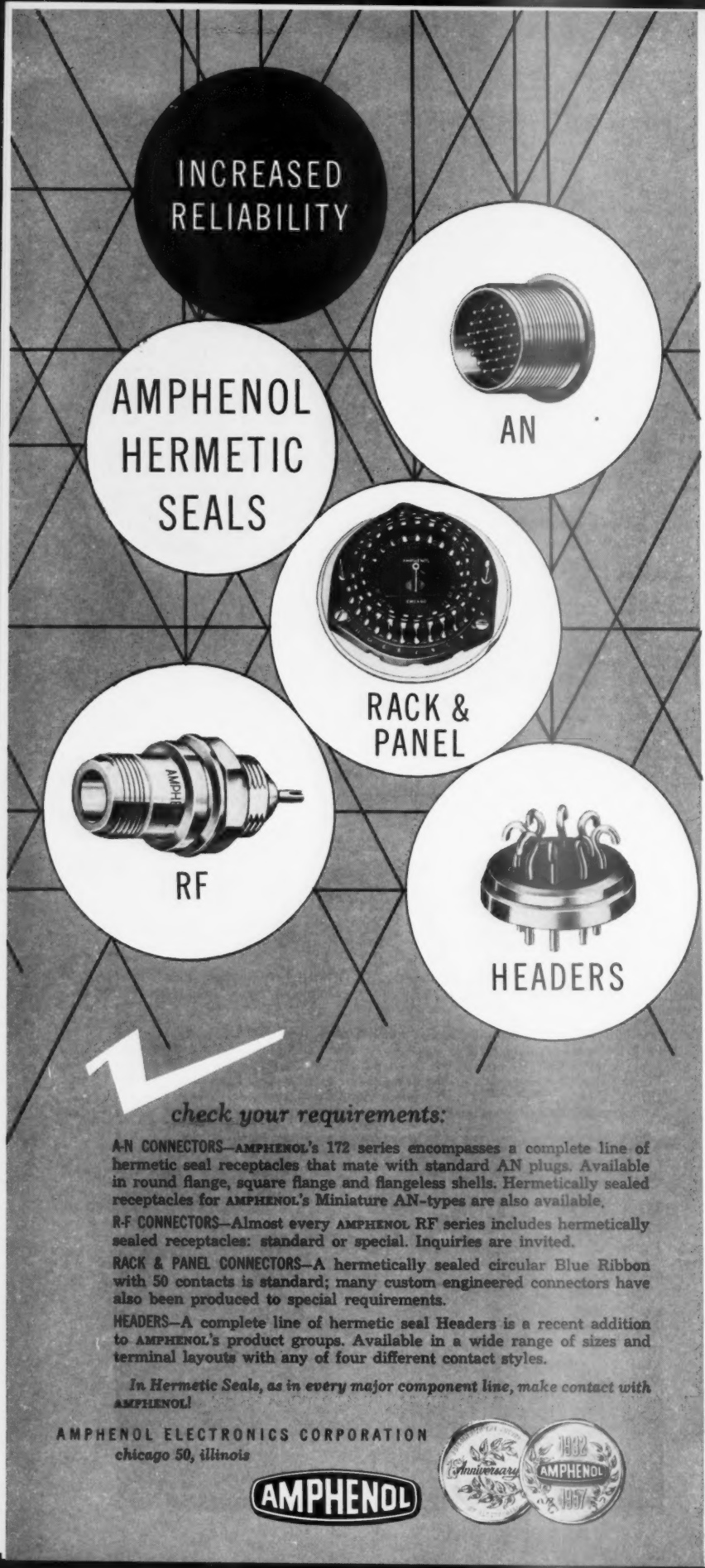
A question-and-answer period followed the panel discussion.

A. W. GILMORE, *Secretary*

San Diego Section

A talk on "Crisis in Air Power" by Cyril Bath, President, Cyril Bath Company, was followed by a panel discussion on

Attending a joint classified dinner meeting of the IAS San Diego Section and SAE December 6 were *(left to right)* P. M. Klauber, Chief Administrative Engineer, Solar Aircraft Company; H. C. Matteson, San Diego Section Chairman and Convair Aerodynamics Group Engineer; guest speaker Col. Horace A. Hanes, USAF, Director of Flight Test, Air Force Flight Test Center, Edwards AFB; and J. H. Famme, Convair Assistant Chief Engineer.


INCREASED RELIABILITY
AMPHENOL HERMETIC SEALS
AN
RACK & PANEL
RF
HEADERS
check your requirements:
A-N CONNECTORS—AMPHENOL's 172 series encompasses a complete line of hermetic seal receptacles that mate with standard AN plugs. Available in round flange, square flange and flangeless shells. Hermetically sealed receptacles for AMPHENOL's Miniature AN-types are also available.
R-F CONNECTORS—Almost every AMPHENOL RF series includes hermetically sealed receptacles: standard or special. Inquiries are invited.
RACK & PANEL CONNECTORS—A hermetically sealed circular Blue Ribbon with 50 contacts is standard; many custom engineered connectors have also been produced to special requirements.
HEADERS—A complete line of hermetic seal Headers is a recent addition to AMPHENOL's product groups. Available in a wide range of sizes and terminal layouts with any of four different contact styles.
In Hermetic Seals, as in every major component line, make contact with AMPHENOL!
AMPHENOL ELECTRONICS CORPORATION
chicago 50, illinois
AMPHENOL
Anniversary
1932
AMPHENOL
1957

"Aircraft Contour Forming" at the December 20 meeting.

The nucleus of Mr. Bath's talk was this quote from an ARDC report: "The current array of machine tools, associate equipment, and manufacturing processes will be completely uneconomical for use on planes envisioned for the future."

Panel members were Oscar Fortis, Convair Long Range Planning Administrator; Fred Hoffman, Lockheed Manufacturing Research Engineer; R. W. Peters, Convair Chief Tool Engineer; and H. G. Engler, Ryan Fabrication Section Superintendent. Technical Chairman was George Schwab of Ryan.

Some 250 IAS and SAE members heard Col. Horace A. Hanes, USAF, Director of Flight Test, Air Force Flight Test Center, Edwards AFB, speak on the AFFTC at a joint, classified meeting December 6.

He spoke on flight-test activities at the Center and discussed facilities used to measure and record various flight parameters. Each phase of the USAF program was described, including problems of modern aircraft and contractor-USAF relations. Aircraft currently undergoing tests were shown on a color film.

Charles L. Critchfield, Director of Scientific Research at Convair, A Division of General Dynamics Corporation, discussed "Controlled Thermonuclear Reactions" at the November 20 meeting.

Dr. Critchfield pointed out recent unclassified developments in thermonuclear reactions with reference to adopting them to power generation.

He illustrated the physics of thermonuclear reactions in the sun, retracing his own early research in the field. He said an unlimited supply of raw material for man-initiated reactions on earth exists in deuterium in sea water. He pointed out that the fusion reaction involved releases much more energy than the fission reaction in ordinary atomic piles.

P. E. CULBERTSON
Corresponding Secretary

Seattle Section

Seattle Section held its January meeting jointly with the Pacific Northwest Section of the American Rocket Society, arranging a social hour and dinner at Gradwohl House. The program drew 230 to the dinner and about 400 to the meeting.

A lecture, "Topics in Relativity Theory and Some Aspects of Antigravity," was delivered by Louis Witten of RIAS, Inc., a subsidiary of The Glenn L. Martin Company.

Dr. Witten said the revived interest in gravitational theory stems from three groups: physicists trying to explain newer discoveries, engineers trying to achieve space travel on inadequate rocket power, and those who are just not satisfied with Newton's laws.

The objective since Einstein's relativity theory of 1916 has been to correlate fully Newton's mechanics and Maxwell's electromagnetic theory to unify and explain all physical phenomena.

Dr. Witten described several concepts and theories and illustrated some classical paradoxes. Verification is virtually impossible in the observer's frame of refer-

Colonel Edward Rassmussen, USAF Training Group Commander, accompanies W. E. Klegka (M) and C. E. Neyland, Program Chairman of the Texas Section during the Section's tour of Perrin AFB.

ence because he is included in all relative notions. He said scientists at RIAS and elsewhere are struggling to attain accuracies in experiments classical and new which will verify or deny the numerous theories that have been advanced and which they themselves can advance.

E. P. Blizard spoke on "Shielding Problems Associated with Nuclear-Powered Aircraft" at the December meeting. Mr. Blizard is Director of the Applied Nuclear Physics Division, Oak Ridge National Laboratory.

He said nuclear power would bring a new and different environment to aircraft. Most such power plants are simply heat generators with much dangerous radiation. He explained how gamma rays and neutrons are produced in fission and their relationship to shielding.

Mr. Blizard said we may expect nothing extraordinary in the way of shielding materials. Most investigations are to find shielding arrangements which are optimum for particular design objectives. A question-and-answer period followed the talk.

THOMAS V. DAVIS, *Secretary*

Texas Section

The Section sponsored a field trip to Perrin Air Force Base at Sherman, on December 8. Perrin is a training base for F-86D pilots and a base for all-weather fighters of the Air Defense Command.

Some 30 members and guests were briefed on the ADC mission and shown facilities at the base through the cooperation of Col. Edward Rassmussen, Training Group Commander. All members had security clearances.

The group inspected ready hangars for all-weather fighters, located at the end of a runway The hangars have fast-acting doors to permit take-off in less than 4 min.

Operation of search radar was observed and techniques of operation explained at the radar center. Radar officers discussed methods of vectoring fighters to targets, locating lost aircraft, and performing blind landings.

A. T. CLEMEN, *Secretary*

Wichita Section

Nearly 70 members and guests heard Lt. Col. James H. Ritter, USAF, speak on "Human Defectiveness in Weapons System Performance" at the December 5 meeting. Colonel Ritter is Chief of the Human Engineering Branch, Human Factors Division, at Air Research and Development Center Headquarters.

He said the ultimate aim of all ARDC study in human research is efficient combat crew deliverance of maximum fire power on a preselected target, in the least amount of time. Study of basic human characteristics is made to determine the advantages of man over machine and machine over man.

Various factors which affect a human operator, such as cabin pressure, temperature, air contamination, noise level, and personal gear, are studied to obtain top operational performance. Man proves better than machine in making decisions based on unsuspected or inconsistent inputs, he said.

The Air Force will continue the study to gather data for putting men in jobs for which they are best suited. He concluded with a plea to designers to take advantage of results already obtained and praised aircraft firms that have established human factors groups to aid designers.

EDWARD J. SULLIVAN, *Secretary*

STUDENT BRANCHES

Iowa State College

James Iverson, a graduate student and part-time Instructor in the Aeronautical Engineering Department, lectured on his summer work-experience at the December 5 meeting.

Mr. Iverson was employed by Sandia Corporation at Albuquerque, N.M. He was assigned to work in the firm's transonic, blowdown wind tunnel dealing with pressures over a solid conical shape.

A British film on *The Crescent Wing* was shown. Structural and aerodynamic advantages of a wing with a crescent-shaped plan form, illustrated in the Handley-Page Victor, were explained.

MARVIN BAXENDALE, *Secretary*

Mississippi State College

Captain F. J. Schwaemmle, Director of Information Services for Delta Air Lines, Inc., of Atlanta, Ga., spoke on "Air-Line Engineering" at the December 13 Branch meeting.

Captain Schwaemmle said a major difference between air-line and industry engineering is the economy factor. Every new idea, design, process, or modification must be weighed in the light of costs. Each improvement must pay for itself, he said.

Maintenance and modification cost statistics were cited to explain the complicated evaluation air-line engineers must give each new item before it is utilized. Numerous experiments must be run on seemingly unrelated items such as lubricants and cleaning compounds as part of an evaluation test.

Captain Schwaemmle told of the thousands of blueprints and parts that are necessary to maintain the aircraft and the effort necessary to keep track of these documents.

He presented Delta scholarships to Robert H. Weir and W. Hugh Parks, Jr.

W. HUGH PARKS, JR., *Secretary*

New York University

Two films were shown after a short business meeting on December 19.

Members saw a movie on North American's *Continental Defender*, *F-68D* and *Flight Report–X-1A*.

James L. Cooley, Supervisor of Aircraft Performance Group, United Aircraft Corporation's Research Department, discussed "Design Evaluation of a Mach 2 Aircraft" at the December 12 meeting. The IAS Branch was joined by members of the American Rocket Society Branch.

Mr. Cooley explained in detail the steps his group takes—gathering information, weighing it, and discarding what is useless—in design work.

Engine data, aerodynamics, and weight

The *New* Pastushin Full-Shear Stress Panel Fastener does what a panel fastener should do!

- absolute positive lock... full shear strength
- automatic spring ejection of stud... no prying to free panel
- curved panel is no problem
- only two assemblies (self-retained)... stud and retainer
- no special installation tools... Phillips head recess

PATENT PENDING

Available now in quantity!

Fastens and unfastens a panel faster and easier than any other fastener on the market!

Check these important features:

Full Shear Strength... stud design transmits full shear strength equal to NAS-547 specification, and/or NAS 334-335 close tolerance bolt.

Positive Mechanical Lock... when stud is seated, it's locked! Visual inspection assures safe lock.

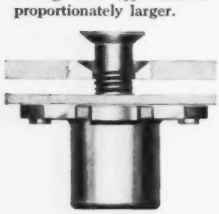
Automatic Stud Ejection... when stud is released, it is automatically spring-ejected from the retainer, allowing panel removal without forcing or prying.

Curved Panels offer no problem...small radius of entry of stud into retainer assembly allows installation and operation on surfaces of less than one inch radius.

Double Lead Stud Thread... assures top performance and trouble-free long service life.

Materials and Finishes... critical bearing surfaces are of CM steel, heat treated to rigid specifications. Steel parts are cadmium plated, aluminum alloy parts anodized.

This is the actual size of the ¼" fastener assembly ...tiny, lightweight and strong. The 5/16" unit is proportionately larger.



Write for complete information on Pastushin's Full-Shear Stress Panel Fasteners, designed for high-strength and simplified securing of access panels and equipment on modern aircraft.

PASTUSHIN INDUSTRIES, INC.

5651 WEST CENTURY BOULEVARD, LOS ANGELES, CALIFORNIA

Affiliate Companies

PASTUSHIN AVIATION CORP. Los Angeles, California | **HAWAIIAN AIRMOTIVE, LTD.** Honolulu, Hawaii

DEVELOPERS AND MANUFACTURERS OF AIRCRAFT FASTENERS

by components were a few of the areas he covered.

A movie on the Boeing 707 Jet Stratotanker was shown at the December 5 meeting. At a short business meeting before the film showing, field trips were planned and discussed.

During December, the Branch grew to a total of 80 members.

MARVIN D. BARKAN, *Secretary*

Polytechnic Institute of Brooklyn

Impressions of aircraft companies were given at the December 19 meeting by members who held summer jobs in the industry.

Firms represented were Northrop, Boeing, Sikorsky, Republic, North American, and the school's Freeport Aerodynamics Laboratory. A short description was given of each firm's activities, policies, and responsibilities given student workers.

All members stressed the value of summer jobs in the industry as an aid for planning a career. A question period was held before the meeting closed.

▶ Allen Pope, Head of the Aerodynamics Department of Sandia Corporation, spoke December 12 on his firm's work with atomic weapon design and manufacture. He cited opportunities for an aeronautical engineer at Sandia.

Dr. Pope introduced a film, *Operation Sandstone*, depicting nuclear weapon tests in the Pacific in 1948.

▶ After a 400-mile trip on December 7, 30 members met at NACA's Langley Field, Va., for a tour of the installation.

NACA had been sharing Navy and Army facilities at Langley for 26 years until an area of its own was provided in 1941. Some 3,000 scientists, engineers, and technicians, all civil service personnel, do research and development work in aerodynamics (with 20 to 25 major wind tunnels, extensive flight testing, and a recent rocket-propelled model technique), structures, and hydrodynamics. A film, *Research for Tomorrow's Aircraft*, gave an insight into NACA's work.

Members saw two 7 × 10 ft. tunnels used for STOL aircraft and helicopter blade configurations.

They inspected a $15.5 million development tool composed of two interconnected tunnels for high Reynolds Number testing over Mach Number ranges of 1.5 to 2.8 and 2.3 to 5.0.

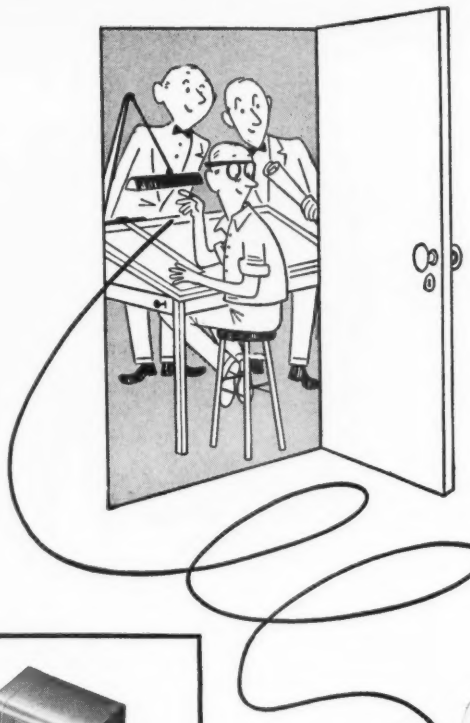
Other sites visited were the Pilotless Aircraft Research Division, Structures Laboratory, Aircraft Loads Calibration Laboratory, and Gas Dynamics Laboratory.

▶ Members at the November 28 meeting saw the film *Experimental Studies of Human Reactions to Impact Forces*. Various shock loads simulating a crash landing were applied to volunteers while instruments recorded their reactions.

▶ Martin Bloom, Branch Faculty Adviser, spoke on the intercontinental ballistic missile November 21, comparing it with the Project Vanguard satellite.

The ICBM carries a several thousand pound pay load some 5,000 miles at 15,000 m.p.h., at an altitude of 600 to 800 miles. This compares to a 20-lb. satellite, to be lifted 300 miles at the same velocity.

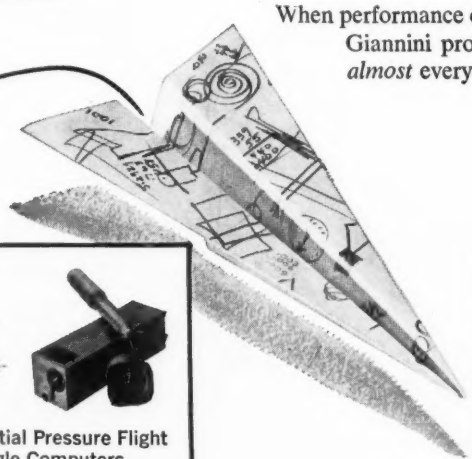
ICBM accuracy will be at best a 10- to 50-mile radius because of geographic

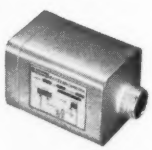


Giannini Instruments and Controls for almost every airborne application

Whether single components or complex packaged systems, virtually all operational military aircraft (and civilian, too) use reliable Giannini precision-crafted instruments and controls.

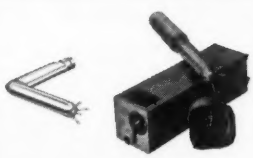
When performance demands precision, specify Giannini products—they're available for *almost* every airborne application.



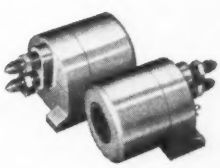


Accelerometers

Temperature Probes

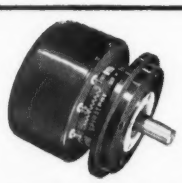


Differential Pressure Flight Angle Computers



Low Pressure Transducers

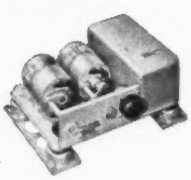
Gyro Instruments



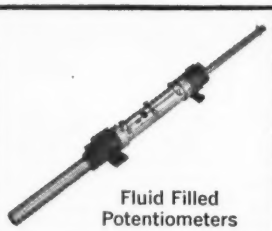
Infinite Resolution Spiralpot Potentiometers

Aerodynamic Angle of Attack Transducers

High Pressure Transducers



Air Data Systems



Fluid Filled Potentiometers

Giannini

INSTRUMENTS · CONTROLS

Engineering positions are open for career-minded young men at several locations—write for details.

REGIONAL SALES OFFICES: NEW YORK 1, N.Y., Empire State Bldg., CHickering 4-4700 • **CHICAGO,** ILL., 8 S. Michigan Ave., ANdover 3-5272
PASADENA, CALIF., 918 E. Green St., RYan 1-7152
FOREIGN SALES OFFICES: LONDON W. 8, ENGLAND, Giannini Limited, 31, Pembroke Gardens

G. M. GIANNINI & COMPANY, INC. • 918 EAST GREEN STREET • PASADENA, CALIF.

ignorance, wind direction, and instrument error—factors which cannot be overcome.

Dr. Bloom's talk was preceded by a film, *The Rocket*, showing the history of rocket development.

▶ On November 14, Dr. Bloom, who considers rocketry the field of the future for aeronautical engineers, spoke on Project Vanguard. He said this experiment is a step toward actual space travel and may well have a significance comparable to the first atomic explosion in nuclear development.

A number of references on the earth's atmosphere were given as an introduction to explaining the satellite's purpose. He covered the size of the three stages and the satellite itself. The launching program and blastoff to final orbit were explained.

▶ Republic Aviation Corporation played host to 32 members who toured the firm's Long Island facilities November 10.

The group began with the jig and pattern shop where metal machining, forming, and welding equipment was inspected. Assembly work and forward and aft fuselage inspection of F-84F and RF-84F aircraft were seen. Especially interesting were cockpit details and electronic and armament installations.

The production line was toured, and members viewed from close by the Wright J65 jet engine. The field trip ended with a bus tour of the firm's flight line.

▶ A film shown November 2 depicted design considerations leading to the Handley Page Victor's usual plan form. Called *The Crescent Wing*, the text centered on airfoil design for minimum drag at high speeds.

By combining the straight, swept, and delta wings, the crescent wing with its highly swept but thick root and almost straight, very thin tip section provides a strong, high Mach Number plan form with room at the root for buried engines and landing gear. The excellent high-altitude performance and low-speed stability of the Victor spoke well of the crescent wing.

Two other films were shown after arrangements for a field trip were completed. The films were *Douglas AD Skyraiders on Board the Valley Forge* and *Douglas D558-2 Skyrocket*.

ALLEN J. SCHNEIDER, *Secretary*

Princeton University

Orville Dunn spoke on design problems of the DC-8 jet transport at the December 4 meeting. Mr. Dunn is Supervisor, Aerodynamics, Stability and Control, Douglas Aircraft Company.

He stressed two points: a comparison of performance of the DC-8 with existing commercial aircraft and a consideration of design features which give the DC-8 its performance.

The jet was compared with the DC-6 and DC-7C with respect to take-off distance, landing run, cost per mile, and pay load. Landing and take-off distances are nearly equal in all three planes, he said. Because of greater speed and weight carrying capability, the jet is cheaper to operate on a ton-mile basis over both long and short ranges. The DC-8 has a longer range than its predecessors.

The jet's better performance is attributable to its wing, a 30-deg. swept surface composed of three different basic airfoil sections. Specially designed, the airfoil has a negative camber. This effect combined with the other airfoil sections produces a wing which stalls at the root first, thereby maintaining lateral control during stall. The wing also has a high CL maximum and a high critical Mach Number.

Mr. Dunn, also explained the aileron and spoiler system for lateral control and the boost system which operates the controls. He described briefly criteria for designing elevator and rudder controls and the method of their actuation. He told of the plane's safety points, including emergency systems and devices used when power fails.

Mr. Dunn illustrated the talk with color slides and answered questions from the audience.

DOUGLAS N. BEATTY, *Vice-Chairman*

San Diego State College

Two films were shown at the December 11 meeting of the Branch. History and development of the Navy's Viking missile were traced in The Glenn L. Martin Company's *Horizon Unlimited*. The Navy jet trainer T2V1 was demonstrated in the second film. Special feature of the plane is its boundary-layer control, designed for low-speed flight.

M. D. CHILCOTE, *Secretary*

Stevens Institute of Technology

A film on the Boeing 707 was shown at the November 19 meeting attended by 36 members and engineering students.

Some of the newer design and development features of the aircraft were illustrated. Flight and ground tests of the 707 also were shown.

The Branch scheduled a tour of the school's towing tank facilities, to be cosponsored by the ASME branch.

GERARD FRIDSMA, *Secretary*

Syracuse University

Recent developments at major European research centers were discussed by John R. Weske, Research Professor at the University of Maryland Institute of Fluid Dynamics and Applied Mathematics, at the November 27 meeting.

Professor Weske located the centers and explained the kind of research each performed. He also showed slides taken on his tour.

Officers elected at a previous meeting are Alan Wait, Chairman; Thomas L. Santilli, Vice-Chairman; and Harry J. Kit, Secretary-Treasurer. Edgar O. Cheney, Jr., and James Gysel were elected Co-Chairmen of a special alumni committee. Salaman Eskinazi is Faculty Adviser.

HARRY J. KIT, *Secretary-Treasurer*

University of Florida

W. S. Evans, Chemical Engineer at Lockheed Aircraft Corporation's Georgia

To the ENGINEER of high ability

Through the efforts of engineers The Garrett Corporation has become a leader in many outstanding aircraft component and system fields.

Among them are:

air-conditioning
pressurization
heat transfer
pneumatic valves and controls
electronic computers and controls
turbomachinery

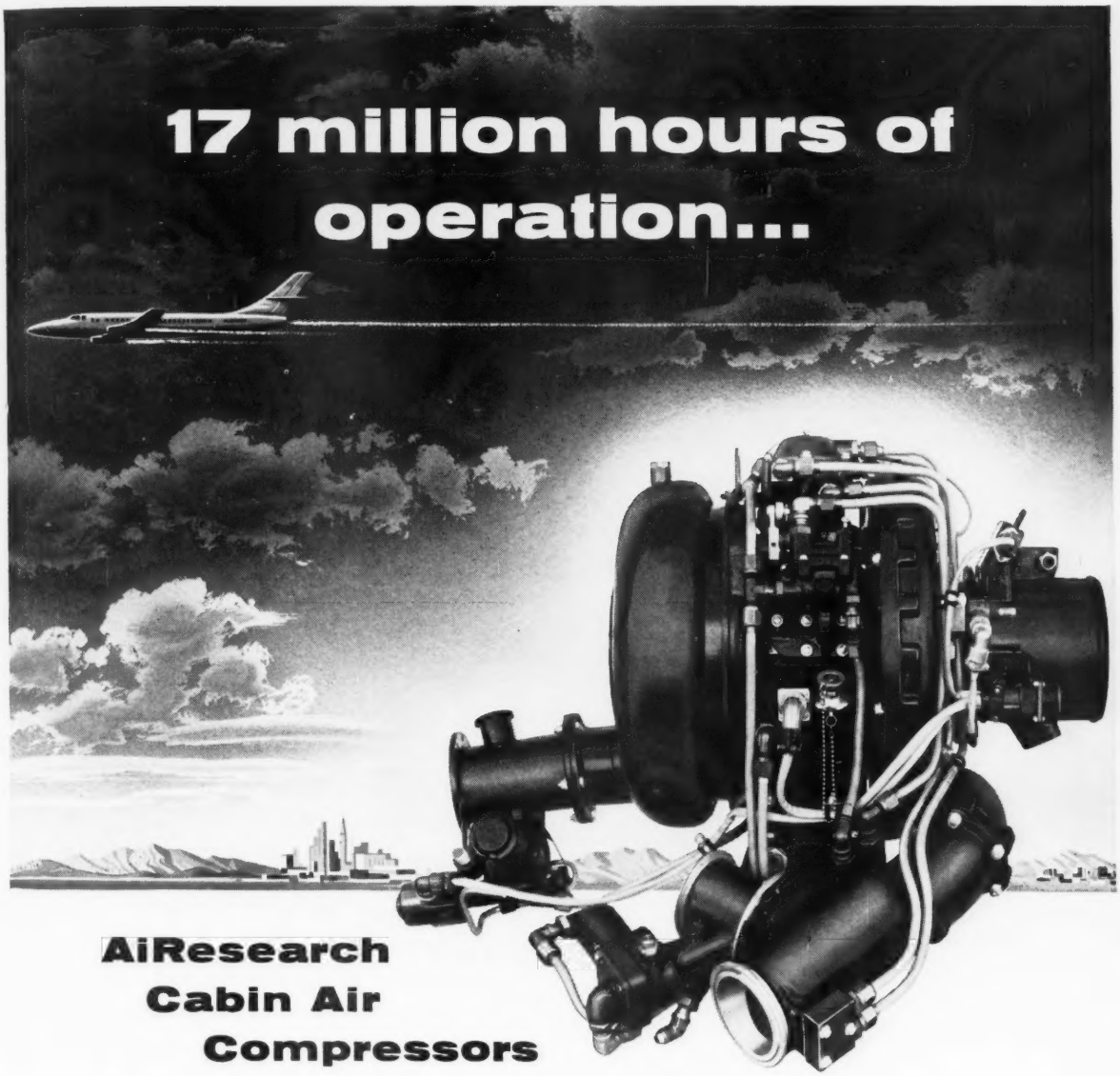
The Garrett Corporation is also applying this engineering skill to the vitally important missile system fields, and has made important advances in prime engine development and in design of turbochargers and other industrial products.

Our engineers work on the very frontiers of present day scientific knowledge. We need your creative talents and offer you the opportunity to progress by making full use of your scientific ability. Positions are now open for aerodynamicists ... mechanical engineers ... mathematicians ... specialists in engineering mechanics ... electrical engineers ... electronics engineers. For further information regarding opportunities in the Los Angeles, Phoenix and New York areas, write today, including a resume of your education and experience. Address Mr. G. D. Bradley

THE GARRETT CORPORATION
9851 So. Sepulveda Blvd.
Los Angeles 45, Calif.

DIVISIONS
AiResearch Manufacturing, Los Angeles
AiResearch Manufacturing, Phoenix
AiResearch Industrial
Rex — Aero Engineering
Airsupply — Air Cruisers
AiResearch Aviation Service

17 million hours of operation...



AiResearch Cabin Air Compressors

Latest designs will soon appear on the most modern turbo-jet (unit shown) and turbo-prop air transports

Cabin air compressors by AiResearch are turbo-driven, shaft-driven or hydraulically-driven. They provide cabin airflows up to 60 pounds per minute at 40,000 feet, with pressure ratios up to 4.3. Their dependability and durability have been service-proved by the most extensive experience in this field — 4000 of these units are now in operation.

These compressors are integrated into complete air conditioning systems. The utmost compatibility is assured, since AiResearch manufactures every component and has experience in every problem of interrelationship between components. We have assumed complete system responsibility in this field for many of America's finest present and projected airliners.

Whether your problem involves components or complete systems, we invite your inquiries.

Outstanding opportunities for qualified engineers. Write for information.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California . . . Phoenix, Arizona

Designers and manufacturers of aircraft systems and components: REFRIGERATION SYSTEMS • PNEUMATIC VALVES AND CONTROLS • TEMPERATURE CONTROLS CABIN AIR COMPRESSORS • TURBINE MOTORS • GAS TURBINE ENGINES • CABIN PRESSURE CONTROLS • HEAT TRANSFER EQUIPMENT • ELECTRO-MECHANICAL EQUIPMENT • ELECTRONIC COMPUTERS AND CONTROLS

Division and guest speaker on December 17, traced developments at the Marietta plant since its reopening.

He told of B-29 overhauling for Korea, B-47 production, and design of the C-130 Hercules. Current designs for a nuclear-powered bomber point out what to expect from the plane in the future, he said.

Mr. Evans showed four films about the Georgia Division. They covered convertibility of the Constellation, plant facilities, hydrostatic testing of the C-130, and paratroop tests using the C-130.

The nominating committee announced the following slate of candidates: Chairman, Paul Bowen and Bob Stroub; Vice-Chairman, Jim Crooker and Bill Nowlin; Corresponding Secretary, Bill True and Ed Blanchette; Recording Secretary, Jim Anderson and Jim Korn; and Treasurer, John Anderson and Shirley Ogram.

John Silvas presented a progress report on the Engineer's Fair and told of a proposed program for poster publicity in all large cities throughout the state. He said acknowledgments concerning exhibits have been received from 14 companies.

▶ Burt Brandon of Chance Vought Aircraft, Incorporated, discussed basic organization of an aircraft company at the December 3 meeting. His informal talk covered a typical firm, from the board of directors to various engineering departments. The engineer was described as having versatility. He may work in various departments or settle for one specialty. But he must be a good salesman and able to cooperate.

New engineers from colleges usually enter special training sections where they go through a period of menial work and are observed for aptitude. The junior engineer in the final phase of his training is moved through various departments to give him a basic knowledge of the firm's fundamental engineering function.

Mr. Brandon concluded by tracing development of a hypothetical aircraft from earliest design phases to final production.

Fred Burns, Don Mallick, and John Silvas were named Co-Chairmen of the Engineer's Fair. Mr. Mallick briefed members on Fair plans and announced the Fair will be on March 8, 9, and 10. Each engineering society will receive $50 to cover exhibit costs.

Members chosen to form a nominating committee were Jim Crooker, Don Mallick Bill True, Ed Blanchette, and John Anderson.

JOHN DAVID ANDERSON
Recording Secretary

University of Kentucky

A 30-min. movie on World War II was shown after the business meeting on December 6.

Members discussed future programs and ways of stimulating interest in the Branch before the film was shown.

ALVIN L. WITTWER, *Secretary*

University of Michigan

The following officers were elected at the December 11 meeting: John Weisenberg, Chairman; Joseph Liu, Vice-Chairman; Mike Reynolds, Secretary; and Roger Severson, Treasurer.

Ross Fleisig of Sperry Gyroscope Company spoke on "Automatic Flight Control and the Aeronautical Engineer" after the business meeting. Some 50 persons, including seven new members, heard Mr. Fleisig explain automatic guidance and stabilization equipment.

Stanley O. Smith was presented with a certificate for winning the IAS Student Paper Contest held between Wayne University, the University of Detroit, and the Michigan branches. The treasurer reported a balance of $66.76 on hand.

Another student paper competition this spring was announced at the November 5 meeting at which Bill Pelzer of North American Aviation, Inc., explained briefly the broad organizational plan of his firm.

Mr. Pelzer discussed how flight test (he is a Flight Test Project Engineer) fits in with this plan. He told of work performed by flight-test engineers and showed color movies of aircraft carrier tests.

Nine new members were among 63 present.

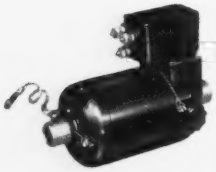
▶ Fred Greene of The Garrett Corporation spoke on the human factor in high-altitude and performance aircraft at the October 9 meeting.

Mr. Greene also discussed physical properties of atmosphere from charts

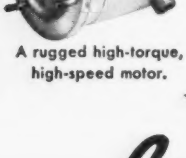
Explosion-proof vacuum unit.

Thoroughbred Fractional HORSEPOWER

for your motor-driven products



Aircraft windshield wiper motor.



A rugged high-torque, high-speed motor.

The unexcelled performance of Lamb Electric Motors in many types of industrial, commercial and domestic products is evidence of their outstanding quality.

Dependability and efficiency (optimum weight-size-horsepower ratio) are features that result from proper design and careful manufacture by personnel having many years of experience in the small motor field.

May we demonstrate how Lamb Electric Motors can bring these advantages — and also perhaps lower costs — to your products?

THE LAMB ELECTRIC COMPANY • KENT, OHIO

In Canada: Lamb Electric — Division of Sangamo Company Ltd. — Leaside, Ontario

Lamb Electric

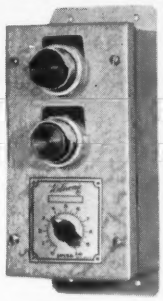
SPECIAL APPLICATION FRACTIONAL HORSEPOWER MOTORS

Weltronic®

ELECTRONIC ADJUSTABLE SPEED DC DRIVE

GIVES 50 TO 1 SPEED RANGE—1/2 OF 1% REGULATION

The Drive Motor is also the Tachometer



WHATEVER YOUR FIELD!

if your production operations involve—

Continuous processing, batching, feeding, conveying, testing, painting, baking, pumping, and the like.

with such problems as—

adjustable speeds, changing duty cycles, frequent reversals, variable volumes, accurate time matching, etc.

adjustable speed d-c drives can help you—

increase production—at less cost than any other method—because you can use the correct speed for each operation.

optional features can be provided

Dynamic braking, quick slow down, current limiting, jogging, reversing, and, the tandem operation of several motors from one panel and control station.

WELTRONIC'S ELECTRONIC ADJUSTABLE SPEED DC DRIVE

Boost Production—
Reduce Automation Costs

This is particularly true if you are engaged in any one of the following industries;—Machine Tool, Metalworking, Rubber, Chemical, Baking, or Papermaking.

AVAILABLE AS A COMPLETE PACKAGE

Anode Transformer Dual primary windings adapt the drive to either 230 or 460 volt, single phase, 50 or 60 cycle power—However transformers can be furnished for any standard power supply.

"Brain" Power Panel Uses drive motor's counter EMF as speed signal and delivers full wave rectified power to drive motor.

Control Station Only a single adjustment knob and push buttons, for the operator, at the control station.

DC Drive Motor It's a standard 240 volt shunt-wound motor.

FEATURES

Motor speed will not vary more than ½ of 1% of rated speed.

Smooth, stepless, adjustable speed range 50 to 1.

Full motor torque over the complete range.

JIC—NEMAXII Enclosure.

Available in 5 sizes—¾ through 3 hp.

Write for Descriptive Literature

WELTRONIC COMPANY

19500 West Eight Mile Road • Detroit 19, Michigan

which were distributed among the 57 members present.

Twenty new members were welcomed.

FRED STEGENGA, *Secretary*

University of Oklahoma

Ward Fuller, Chief of Production Engineering for Aero-Design Aircraft Company, Bethany, Okla., spoke on "Aircraft Preliminary Design" at the January meeting.

Mr. Fuller stressed detail design. He said detail design is too often ignored and it can be of great importance to final design. He explained some of the criteria used in developing a new airplane so that the craft may be improved and modified later with a minimum of effort and with little change in configuration.

Prior to his talk, members discussed participation in the University's Engineering Open House.

▶ Highlight of the December meeting was a discussion of the Civil Aeronautics Administration led by John Paul Jones, CAA Chief Flight Engineer.

Mr. Jones told of the procedure followed by aircraft companies to have an airplane registered with the CAA. He explained the numerous flight tests that must be conducted before the plane may be approved.

A guest at the meeting was Capt. W. B. Mechling, USN, Professor of Naval Science at the university. Captain Mechling joined the IAS in 1938 at the California Institute of Technology.

▶ Robert Dickinson of Douglas Aircraft Company, Inc., spoke on "Aircraft Modernization" at the November meeting. Chief Liaison Engineer at the firm's Tulsa plant, he said industry is constantly developing improvements for aircraft—even after production has begun.

Changes are necessary to correct faults, improve capabilities, and, in general, keep planes up to date. He explained procedures for accomplishing changes.

The annual student paper competition held by the IAS Texas Section was explained by the Faculty Adviser at the business meeting. He urged members who were interested to begin work as soon as possible for the competition.

JAMES R. BRACE, *Secretary*

University of Pittsburgh

Senior Anthony Kurpiewski spoke on "The History of Aeronautical Research Organizations" at the November 29 meeting.

He discussed the development of NACA to whose Cleveland laboratories the Branch had made a field trip the previous week.

Chairman Donald P. Rooney summarized the field trip. It was highlighted by a tour of the supersonic wind tunnel which, he said, fascinated the 23 members with its huge size and hydraulically adjustable throat section.

DENNIS T. NEUMAN, *Secretary*

University of Wichita

A field trip to Ken-Mar Airpark where the university's Research Department is conducting flight tests on the Helio-Courier STOL aircraft preceded the November 30 formal meeting.

Test pilot Jack Craig demonstrated short take-off and landing capabilities of the aircraft. After the flight, he pointed out interesting design features such as slotted leading edges and spoilers on the wings and flying tail.

During the formal meeting of the Branch Mr. Craig spoke on the three phases of flight test—performance, stability and control, and take-off and landing capabilities. He said the plane can take off and land over a 50-ft. obstacle within 485 ft.

Members agreed to build a supersonic nozzle for demonstration at the university's coming Open House.

WARREN CHICHESTER, *Secretary*

MEMBERS ELECTED

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the Review.

Transferred to Associate Fellow Grade

Bender, Welcome W., M.S., V-P, Rias, Inc.

Brodsky, Robert F., Sc.D., in Ae.E., Chief of Aerodynamics, Convair Div. (Pomona), General Dynamics Corp. (*Erratum—page 94, December, 1956,* REVIEW.)

Dorrance, William H., M.S. in Ae.E., Asst. to Dir. of Scientific Research, Convair Div. (San Diego), General Dynamics Corp.

Ebert, John W., Jr., B.S. in Ae.E., Sect. Head, R&D Dept., Goodyear Aircraft Corp.

Hawkins, Willis M., B.S. in Ae.E., Dir. of Engrg., Missile Systems Div., Lockheed Aircraft Corp. (Van Nuys).

Kirk, Jacques A., Head, Wind Tunnel Dept., The de Havilland Aircraft Co., Ltd.

Thorn, Gordon P., B.S., Asst. Chief Engr., Lockheed Aircraft Corp. (Marietta).

Trimble, George S., Jr., S.B. of Ae.E., V-P—Engrg., The Glenn L. Martin Co.

Elected to MEMBER Grade

Baltakis, Frank P., M.Sc., Instructor in Aero. Engrg., Univ. of Pittsburgh.

Beebe, John, B.S. in Ae.E., Aero. Engr., Dept. of the Army (Washington, D.C.).

Beheim, Milton A., M.S. in Ae.E., Aero. Research Scientist, NACA (Cleveland).

Corrington, Lester C., B.S. in E.E., Head, Altitude Test Chambers Section, NACA (Cleveland).

Drew, Richard E., B.S. in Math., Devel. Engr., Curtiss-Wright Corp.

Flack, Nelson D., M. of Ae.E., Asst. Chief, Flight Research Branch, USAF (Edwards AFB).

Jones, Paul E., Engr., Sperry Gyroscope Co. Div., Sperry Rand Corp.

Klosner, Jerome M., M.S., Research Assoc., Polytechnic Institute of Brooklyn.

Koenig, Robert J., B.S. in M.E., Research Engr., Convair Div. (San Diego), General Dynamics Corp.

Lawrence, David M., Aerodynamics Engr., Lockheed Aircraft Corp. (Marietta).

Little, Stanley M., Jr., B.S., Admin. Engr., Boeing Airplane Co.

Masson, David J., M.Sc., Engr., The RAND Corp.

Mendenhall, Robert, B.S. in Ae.E., Pres., Ketco, Inc.

Miselis, Victor W., B.S., Sr. Scientist, Avco Manufacturing Corp.

Moser, Virgil G., Aviation Safety Agent, CAA (Muskegon).

Nelson, Robert E., B.E.E., Mgr., Aviation & Defense Industries Sales, General Electric Co. (Minneapolis).

Parker, Paul E., B.A., Engr., Reliability, Temco Aircraft Corp.

Peters, Edward F., B.S. in Ae.E., Asst. Proj. Engr., McDonnell Aircraft Corp.

Shelley, Rulon G., M.S. in E.E., Asst. Mgr., Fire Control Engrg., North American Aviation, Inc. (Downey).

Stahle, Clyde V., Jr. B.S. in M.E., Dynamics Engr., The Glenn L. Martin Co.

Weihe, Vernon I., B.S. in E.E., Staff Consultant, Air Transport Associates of America, and Melpar, Inc.

Williams, Thomas J., B.S. in Ae.E., Proj. Engr., USAF (Eglin AFB).

Wilson, Paul H., B.S. in E.E., Mgr., Aircraft Instrument Engrg. Admin. Practices, General Electric Co. (West Lynn).

Zepf, Richard J., B.S. in Ae.E., Design Engr., Marquardt Aircraft Co.

Transferred to MEMBER Grade

Bulinski, Ronald J., B.S. in Ae.E., Aerodynamics Engr., Convair Div. (San Diego), General Dynamics Corp.

Bulmer, Harry R., M.S. in Ae.E., Major, USAF; Instructor, Propulsion Courses, Air Force Institute of Technology (Wright-Patterson AFB).

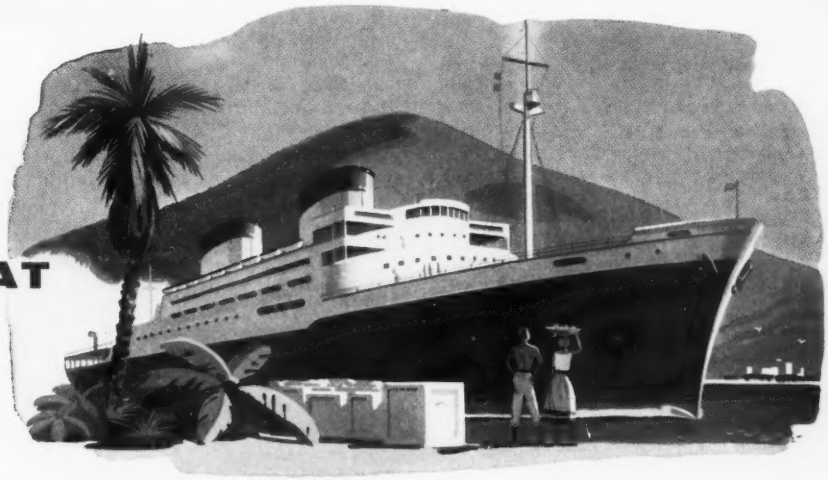
Cohen, Nathaniel B., B.S. in Ae.E., Sr. Scientist, Aerodynamics, Research and Advanced Devel. Div., Avco Manufacturing Co.

Crissey, Jackson R., B.S. in M.E., Lead Designer, Chance Vought Aircraft, Inc.

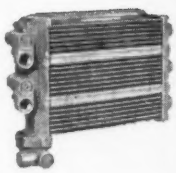
Fletcher, Herman S., B.S. in Ae.E., Aero. Research Scientist, NACA (Langley Field).

Franks, Ralph W., M.S. in Ae.E., Flight Test Engr., General Electric Co. (San Francisco).

TROPIC HEAT



OR ARCTIC COLD



Harrison Heat-Exchangers Keep Temperatures Level!

Harrison goes to any extreme to keep temperatures on the beam . . . to keep temperatures normal under all types of operating conditions! These top-quality heat-exchangers are busy everywhere —on land, on sea, and in the air . . . guarding critical engine temperatures and providing safe, sure performance. They're lightweight and compact, too—designed to save you space and money. That's why Harrison is a leader in its field—that's why so many manufacturers rely on Harrison *exclusively* for dependable, economical heat-transfer equipment. If *you* have a cooling problem, look to Harrison for the answer.

GM GENERAL MOTORS

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N. Y.

Watch WIDE WIDE WORLD Sundays on NBC-TV

HARRISON

TEMPERATURES MADE TO ORDER

Heilicer, Bernard J., B. of Ae.E., Group Engr., Republic Aviation Corp.

Heyson, Harry H., B. of Ae.E., Aero. Research Scientist, Rotary Wing, NACA (Langley Field).

Kueser, Paul E., B.S. in Ae.E., Engr., Atomic Energy Liaison Group, AGT Div., Westinghouse Electric Corp. (Kansas City).

LaBerge, Jerome G., M.S. in Ae.E., Asst. Research Officer, National Research Council (Ottawa).

Mann, Charles C., M. of Ae.E., Sr. Propulsion Engr., Convair Div. (Ft. Worth), General Dynamics Corp.

McCaughey, Owen J., B.S. in M.E., Aerodynamics Engr., Propulsion Research Corp.

Shivers, James S., B.S. in Ae.E., Aero. Research Engr., NACA (Langley Field).

Smith, Giles K., B.S. in Ae.E., Assoc. Engr., The RAND Corp.

Sowa, William W., B.S. in Ae.E., Proj. Thermodynamicist, Goodyear Aircraft Corp.

Stannard, Edward A., B. of M.E., Instructor in Aero. Engrg., Univ. of Illinois.

Swanger, John W., B.S. in Ae.E., Stress Technologist, Fairchild Aircraft Corp. (Hagerstown).

Thirolf, Robert G., B.S. in E.E., Electrical Group Leader, Missile Div., McDonnell Aircraft Corp.

Wagoner, Cleo B., B.S. in Ae.E., Aero. Research Scientist, Ames Aeronautical Lab., NACA (Moffett Field).

Williams, Claude V., B.S. in Ae.E., Sr. Aerodynamics Engr., Lockheed Aircraft Corp. (Marietta).

Elected to Associate Grade

Bieber, Ray E., M.S. in Ae.E., Stress Engr. "A," Douglas Aircraft Co., Inc. (El Segundo).

Breland, Hunter M., B.S. in M.E., Propulsion Engr., Convair Div. (Ft. Worth), General Dynamics Corp.

Hartholz, Marshall J., Engr., Boeing Airplane Co. (Seattle).

Kettering, E. W., Dir. of Research, Electro Motive Div., General Motors Corp. (La Grange).

Martin, Donald S., B.S., Pilot Training, USAF (Goodfellow AFB).

Miluschewa, Sima, M.S. in M.E., Research Engr., Curtiss-Wright Corp.

Oakley, Ralph B., Supvr., Contract Admin., North American Aviation, Inc. (Downey).

Osterlind, John R., B.S. in Indus. Engrg., Proj. Engr., The Ralph M. Parsons Co.

Shepherd, Robin, B.Sc. in C.E., Stressman, The de Havilland Aircraft Co., Ltd.

Wing, Lawrence D., B.S. in C.E., Struct. Engr., The Glenn L. Martin Co.

Transferred to Associate Grade

Allen, James E., Jr. Engr., Parker Aircraft Co.

Annis, Charles W., M.Sc., Engr., Dynamic Sciences Group, North American Aviation, Inc. (Columbus).

Bettes, William H., Jr., Assoc. Test Proj. Engr., Southern California Cooperative Wind Tunnel.

Blackson, Walter J., B.S. in M.E., Design Engr., North American Aviation, Inc. (Columbus).

Briggs, Clarence A., B.S. in M.E., Aerodynamics Engr., Convair Div. (Ft. Worth), General Dynamics Corp.

Cearley, James E., Design Engr., Rocketdyne Div., North American Aviation, Inc. (Canoga Park).

Chevalier, Howard L., Proj. Engr., ARO, Inc.

Clarke, Norris W., Buyer, Rohr Aircraft Corp.

Doherty, John C., B.S. in Ae.E., Flight Test Engr., Boeing Airplane Co.

Ellis, Atlee R., Capt., USAF; Field Maintenance Officer.

Ewen, Robert J., B.S. in Ae.E., Jr. Engr., Chance Vought Aircraft, Inc.

Fagan, William M., B.S. in Ae.E., Capt., USAF; Flight Test Maintenance Officer.

Gordon, James T., Jr., B.S. in M.E., Capt., USAF; Proj. Engr. (Wright-Patterson AFB).

Graham, Raymond A., Lt. Col., USAF; Squadron Comdr.

Grissom, Virgil I., B.S. in M.E., Capt., USAF; Student Test Pilot (Edwards AFB).

Holmon, Robert R., B.S. in Ae.E., Performance Engr., AGT Div., Westinghouse Electric Corp. (Kansas City).

Kirsch, Richard A., B.S. in Ae.E., Aerodynamicist, Grumman Aircraft Engineering Corp.

Mergl, Richard A., B.S. in Ae.E., Lt., USN; Graduate Student, Iowa State College.

Mitchell, Hugh, Jr., B.S., Capt., USAF; R&D Staff Asst. (Wright-Patterson AFB).

Oberg, Merle L., Design Draftsman, Coleman Engineering Co.

Olle, David L., Field Service Rep., Rocketdyne Div., North American Aviation, Inc. (Van Nuys).

Panek, George J., B.S. in Ae.E., Asst. Engr., Marquardt Aircraft Co.

Parks, John F., B.S., Helicopter Dept., Cessna Aircraft Co.

Ranslem, Gerald R., Assoc. of Arts, Asst. Engr., Marquardt Aircraft Co.

Roberts, Albert M., B.S. in M.E., Design Engr., North American Aviation, Inc. (Columbus).

Sameshima, Ko S., B.S. in Ae.E., Design Engr., WADC (Wright-Patterson AFB).

Shewmaker, Alan P., B. of Ae.E., Assoc. Aircraft Engr., Lockheed Aircraft Corp. (Marietta).

Smith, Richard T., B.S. in Ae.E., Assoc. Engr., Convair Div. (Ft. Worth), General Dynamics Corp.

Spiegler, Stuart D., B. of Ae.E., Sperry Gyroscope Co. Div., Sperry Rand Corp.

Thoren, Arthur R., B.S. in Ae.E., Struct. Design Engr., The Glenn L. Martin Co.

(*Continued on page 172*)

FIVE IMMEDIATE OPENINGS FOR DESIGN ENGINEERS

★

Armament Design Engineer. To design, install and test gun, rocket and missile systems. Requires degree in Engineering and either one year armament installation design experience, or three years general design experience.

★

Senior Surfaces Design Engineer. To create production design of wing, tail and control surfaces for missiles and fighter aircraft. Engineering degree and four years design experience.

★

Senior Hydraulics Designer. For development, detail design and test work on complex hydraulic power control systems. Engineering degree and at least four years experience in hydraulic design.

★

Support Equipment Engineer. For a wide range of development assignments including complete airborne photo systems and submarine handling equipment for guided missiles. Engineering degree and at least three years design experience.

★

Designer for Pilot Escape System. Requires Engineering degree and at least three years work with pilot escape mechanisms, plus other related practical design experience.

To arrange for a personal interview, or for a prompt, confidential report on these openings, write to:

Mr. J. W. Larson, Asst. Chief Engineer
Dept. AER-2

CHANCE VOUGHT AIRCRAFT
INCORPORATED DALLAS TEXAS

A Vought Vignette

FIRST IN A NEW SERIES

The Aircraft Designer Who Went to Sea . . .

IT WAS A ROUTINE CRUISE for the *Bon Homme Richard*. But for Wayne Burch, it was a memorable climax to months of hard work. Aboard the carrier with the Chance Vought design specialist was the white-lacquered fighter he'd worked on so long.

★

Wayne had joined the Crusader dayfighter project in Preliminary Design, on alighting and arresting gear. He'd transposed his initial drawings into detail design and, later, he'd watched his gear pass jig and aircraft drop tests. At the Navy Test Center, the Crusader's gear absorbed maximum sink speeds and arresting tension, and Burch once more was there.

★

Now, Navy pilots on the *Bon Homme Richard* were taking the Crusader to sea, and Burch was going along. This time his assignment was simply to watch, and this time the Crusader was to be just part of the picture. Vought wanted him to experience carrier life and to see how his new weapon fitted in. For Wayne, whose sea log began and ended with one day's fishing from a 20-foot launch, it promised to be an eye-opening voyage.

For six days the designer shared quarters with Navy fighter pilots and had coffee with maintenance men. He studied aircraft spotting and catapulting, and he learned the sign language of the LSO (Landing Signal Officer). He marveled at the fingersnap timing of the Navy's deck handlers and at the *Bon Homme Richard's* mid-voyage refueling of two bobbing destroyers.

★

Wayne calls it "one of the most enjoyable weeks of my life" . . . and, as other sea-going Vought engineers have discovered, "one of the most profitable, too.

"Now I know the pilot's job, what maintenance wants . . . how really big the operation is.

"It's something you don't get if you stick too close to design.

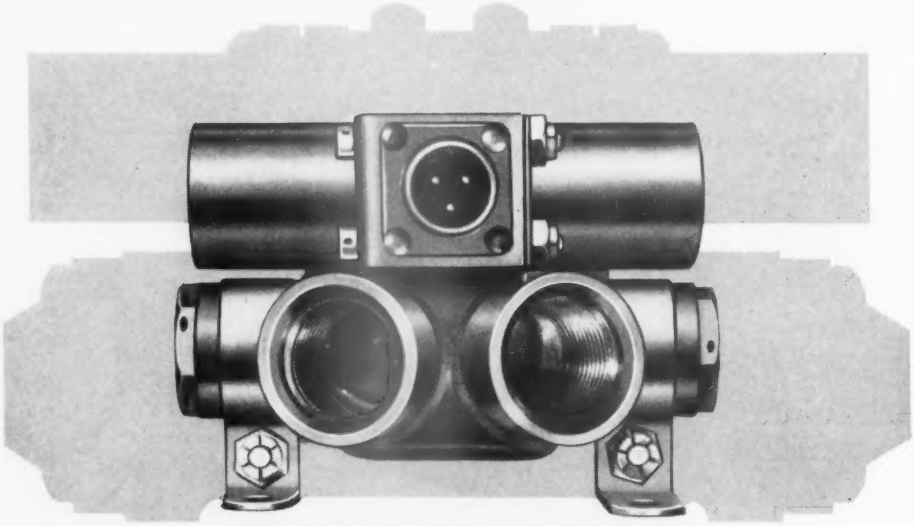
"I guess you'd call it *perspective*."

At Chance Vought the designer stays in touch with his product . . . Contact begins in development, extends through test and includes, when possible, a study by the designer of the tactical environment in which his weapon will serve.

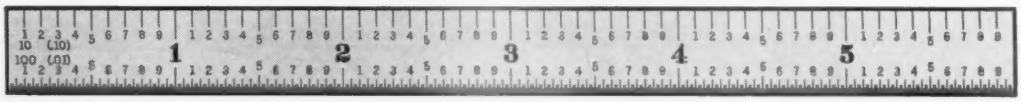
CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

ADEL "DESIGN SIMPLICITY" FOR PERFORMANCE RELIABILITY

New Steel Body, Miniature, Solenoid Operated Directional Control Valves



OLD AND NEW VALVES ACTUAL SIZE



SPECIFICATIONS

Non-Interflow, Low Surge Design Types I & II Sys. (−65°F to +160°F & +275°F) Corrosion Resistant Construction

Operating Pressure Range: 250 to 3000 PSI
Total Pressure Drop: 60 PSI at Rated Flow
Internal Leakage: 10 cc/ Min. Max. at 90°F

Solenoids: Continuous Duty, Single Dry Coil, 18 to 28 V dc operation at −60°F to +275°F
Current Drain: 1 Amp Max. at 28 V dc

Performance and qualification based upon Oil, Specification MIL-0-5606, but suitable for other fluids

Compared with similar valves having aluminum bodies and steel components, these new valves provide: ▶

- 1/5 number of seals
- 1/2 number of parts
- 1/2 space requirements
- 1/2 weight

DESIGNED FOR EXTENSIVE STANDARDIZATION OF PARTS

VARIATIONS

- 2 and 3 Position, 4 Way
- 2 and 3 Position, 4 Way with Solenoid Manual Override
- 3 Position, 4 Way with Piston Manual Override
- Line Sizes: ¼, ⅜ and ½ Inch Ports per AND 10050

Write today for new descriptive Brochure

Reliability

ADEL PRECISION PRODUCTS

A DIVISION OF GENERAL METALS CORPORATION

BURBANK, CALIFORNIA • HUNTINGTON, WEST VIRGINIA
DISTRICT OFFICES: MINEOLA • DAYTON • WICHITA • DALLAS • TORONTO

Designers, Developers, Manufacturers and Testers of Hydraulic, Pneumatic, Fuel, Mechanical and Electrical Equipment, and Line Supports

Aeronautical Reviews

A Guide to the Current Literature of Aeronautical Research and Engineering

THIS SECTION reviews important periodicals, technical and research reports, and books received in the IAS Library in order to provide basic documentation for engineers and scientists.

INTERNATIONAL AERONAUTICAL ABSTRACTS, published as an insert in each issue, is an accelerated reviewing service covering worldwide scientific and technical literature. This work is performed by the IAS Staff and is supported by the Air Force Office of Scientific Research of the Air Research and Development Command.

A list of the periodicals and reports series received in the IAS Library is published semiannually, in the January and July issues.

The AERONAUTICAL ENGINEERING INDEX, published since 1947, provides an annual cumulation of the materials reviewed in this section.

THE IAS LIBRARY

Publications reviewed in this section are maintained by the Library for use by the IAS Membership. They are *not* for sale but are made available through the facilities of the Library.

LENDING SERVICES: Institute members, both Individual and Corporate, may borrow periodicals, reports, and books for a period of 2 weeks, excluding time in transit. Excepted are certain reference books and those IAS publications that may be purchased.

PHOTOCOPY SERVICES: The Library is equipped to provide, as a service, positive photocopies of certain materials in its collections. Rates on request.

For detailed information about these and other services, write to:

John J. Glennon, Librarian
Institute of the
Aeronautical Sciences, Inc.
2 East 64th Street
New York 21, New York

PERIODICALS & REPORTS 84

INTERNATIONAL AERONAUTICAL ABSTRACTS. 101

BOOKS 167

Subject Index to Periodicals & Reports

Acoustics, Sound, & Noise 84
Aerodynamics 84
  Aerothermodynamics 84
  Boundary Layer 86
  Control Surfaces 88
  Fans 88
  Fluid Mechanics & Aerodynamic Theory 90
  Internal Flow 94
  Stability & Control 98
  Wings & Airfoils 98
Aeroelasticity 117
Aeronautics, General 118
Air Transportation 118
Airplane Design 118
  Air Conditioning & Pressurization 120
  Landing Gear 120
  Operation & Performance 122
Airports 122
Aviation Medicine 122
Computers 122
Education & Training 122
Electronics 122
  Amplifiers 122
  Antennas 124
  Circuits & Components 124
  Communications 124
  Construction Techniques 124
  Cooling 124
  Dielectrics 124
  Electronic Tubes 126
  Magnetic Devices 126
  Measurements & Testing 128
  Noise & Interference 128
  Oscillators & Signal Generators 128
  Power Supplies 128
  Radar 128
  Resistors 128
  Semiconductors 128
  Transmission Lines 128
  Wave Propagation 130
Equipment
  Electric 130
  Hydraulic & Pneumatic 130
Flight Operating Problems 130
Flight Testing 130
Fuels & Lubricants 130
Ice Formation & Prevention 132
Instruments 132
  Automatic Control 132
  Flow Measuring Devices 134
  Temperature Measuring Devices 134
  Vibration Measuring Devices 134
Laws & Regulations 134
Machine Elements 134
  Bearings 134
  Gears & Cams 136
Maintenance 136
Materials 136
  Ceramics & Ceramals 136
  Corrosion & Protective Coatings 136
  Metals & Alloys 136
  Metals & Alloys, Nonferrous 136
  Nonmetallic Materials 138
  Testing 142
Mathematics 142
Meteorology 144
Missiles 146
Navigation 146
  Electronic Aids 146
Photography 146
Physics 146
Power Plants 150
  Atomic 150
  Jet & Turbine 150
  Rocket 152
Production
  Metalworking 152
  Production Engineering 152
  Tooling 152
  Welding 152
Refueling in Flight 152
Rotating Wing Aircraft 152
Safety 154
Space Travel 154
Structures 154
  Beams & Columns 158
  Cylinders & Shells 158
  Elasticity & Plasticity 158
  Plates 160
  Sandwich Structures 161
  Testing 161
  Thermal Stress 161
  Wings 161
Thermodynamics 161
  Combustion 161
  Heat Transfer 161
VTOL & STOL 162
Wind Tunnels & Research Facilities 162

Acoustics, Sound, & Noise

Aircraft Noise. R. Cox Abel. *Aeronautics*, Dec., 1956, pp. 26–28. Discussion on the theory of sound propagation and possible methods to alleviate noise from aircraft.

Boundary-Layer-Induced Noise in the Interior of Aircraft. H. S. Ribner. (*UTIA Rep. 37*, Apr., 1956.) *Can. Aero. J.*, Dec., 1956, pp. 350–353. Abridged.

Inlet Noise Reflector. J. M. Tyler and R. Krieghoff. *SAE J.*, Dec., 1956, pp. 57–59. Description of a portable reflector for use during ground testing of jet engines outside test cells.

Jet Noise Suppression Can Best be Accomplished by Combinations of Three Fundamental Methods. M. M. Miller. *SAE J.*, Dec., 1956, p. 59. Abridged. Discussion of the frequency-shifting, alteration of jet mixing, and velocity-reduction methods of noise suppression.

Focusing of Acoustic Waves by Means of Inhomogeneous Media. L. M. Brekhovskikh. *Soviet Physics-Acoustics*, No. 2, 1956 pp. 124–133. Translation. Development of a method for calculating the focusing of waves in laminarly inhomogeneous media. The field of a point-source emitter is represented in integral form, and the reflection coefficients of plane wave are introduced into this form. The subsequent application of the inflection-point method to the integral yields the field in a ray approximation.

The Transition to a Geometric Approximation in the Theory of Elasticity. M. L. Levin and S. M. Rytov. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 179–184. Translation. Analysis which shows that the law of variation of shear-wave polarization along corresponding rays follows from the linearized equations of the theory of elasticity in a geometric approximation, along with the equation of the eikonal and the laws of conservation of energy flow in the compression and shear waves.

Experimental Investigation of Ultrasonic Transition Layers. G. I. Kaminir and B. D. Tartakovskii. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 159–165. Translation. Study of a method producing acoustic penetration (translucence) at the boundaries of acoustically different media by means of transition layers.

The Scattering and Radiation of Waves by Statistically Inhomogeneous and Statistically Oscillating Surfaces. M. A. Isakovich. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 149–153. Translation.

A Modulation Method of Measuring Ultrasonic Dispersion. V. A. Zverev. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 144–148. Translation. Method for the direct measurement of wave dispersion, based upon the variation in the nature of the modulation of a wave when it is propagated in a dispersing medium.

The Problem of Waveguide Propagation of Sound in Inhomogeneous Media. Iu. L. Gazarian. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 134–138. Translation. Derivation for the field of a point-source spherical emitter which is located in a laminarly inhomogeneous medium where the velocity of sound varies according to the law indicated by Epstein.

One Approximate Solution for the Problem of the Scattering of Acoustic Waves by an Uneven Surface. Iu. P. Lysanov. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 190–197. Translation. Method for calculating the scattering of acoustic waves on an uneven surface, based on the solution of an approximate integral equation for the normal component of the wave velocity on the scattering surface.

Scattering of Sound Waves by Sinusoidal and Saw-Tooth Surfaces. A. N. Leporskii. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 185–189. Translation. Comparison of test results on the scattering of acoustic waves by sinusoidal and sawtooth surfaces with the Lysanov theory.

Non-Mirrorlike Reflection of Sound by a Thin Cylindrical Shell. L. M. Liamshev. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 198–203. Translation. Analysis which shows that the nonmirrorlike reflection from a bounded shell is dependent on the vibrations of the shell excited by the external field.

Correlation Properties of a Wave in a Medium with Random Inhomogeneities. L. A. Chernov. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 221–227. Translation. Calculation of the coefficient of longitudinal spatial autocorrelation for fluctuations in level and in phase. It is shown that the longitudinal correlation extends over a distance which is appreciably greater than that over which the transverse correlation extends.

Propagation of Waves in a Medium with Random Inhomogeneities of the Index of Refraction. V. A. Krasil'nikov and A. M. Obukhov. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 103–110. 23 refs. Translation. Review of phenomena which arise during the propagation of waves in a medium with weak random inhomogeneities caused by turbulence.

Experimental Investigation of Relaxation Processes which Arise When Ultrasonic Waves Pass Through Liquids. Iu. N. Bormosov, V. F. Nozdrev, V. D. Sobolev, and A. M. Sultanov. *Soviet Physics-Acoustics*, No. 2, 1956, pp. 118–123. Translation. Study of experimentally detected relaxation processes in acetates and formates. The tests were conducted by means of the pulse and optical methods at frequencies of 1–30 mc.

Aerodynamics

Flow Conditions in a Slip Stream. F. Weinig. (*Lilienthal-Gessellschaft fur Luftfahrtforschung, Jahrbuch 1936.*) *Miss. State Coll., Aerophys. Dept., Translation*, Aug. 23, 1956. 46 pp. 14 refs. Investigation to determine the influence of the slipstream on the tail unit, spanwise load distribution, lift and drag, and the pitching, rolling, and yawing moments.

Report of the Pressure Panel on the Definitions of Quantities Having the Dimensions of Pressure. *Gt. Brit., ARC CP 281*, 1956. 4 pp. BIS, New York, $0.18. Definitions of the terms static, total, stagnation, dynamic, indicated dynamic, kinetic, pitot, momentum, and reaction pressures.

Similitude Relations for Free-Model Wind-Tunnel Studies of Store-Dropping Problems. Appendix—**Test Method Used in The Preflight Jet.** Carl A. Sandahl and Maxime A. Faget. *U.S., NACA TN 3907*, Jan., 1957. 26 pp.

Aerothermodynamics

On the Calculation of Heat and Mass Transfer in Laminar and Turbulent Boundary Layers. I—The Laminar Case. II—The Turbulent Case. D. R. Davies and D. E. Bourne. *Quart. J. Mech. & Appl. Math.*, Dec., 1956, pp. 457–488. 22 refs.

The Solution of Compressible Laminar Boundary Layer Problems by a Finite Difference Method. Irmgard Flügge-Lotz and Donald C. Baxter. *Stanford U., Div. Eng. Mech. TR 103* (*AFOSR TN 56-544*), Sept. 30, 1956. 77 pp. 32 refs. Method which allows the determination of boundary-layer behavior under any combination of pressure gradient and wall temperature, or heat-transfer rate variation.

Comments on "Flight Measurements of Aerodynamic Heating and Boundary Layer Transition on the Viking 10 Nose Cone." Eldon L. Knuth. *Jet Propulsion*, Dec., 1956, pp. 1,101–1,103. Correlation of heat-transfer data, taking into account the variation of fluid properties with temperature in the boundary layer and the effect of the three-dimensional nature of flows over cones.

A Note on the Effect of Centrifugal Forces and Accelerated Motion on the Instability of the Laminar Boundary Layer About Highly Cooled Bodies. Antonio Ferri and Roberto Vaglio-Laurin. *Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech., PIBAL Rep. 313* (*AFOSR TN 56-579*)[*AD 115002*], Dec., 1956. 13 pp. Theoretical investigation of a possible transition mechanism on highly cooled surfaces having a large curvature.

The Effect of an Arbitrary Distribution of Surface Temperatures on Heat Transfer in the Compressible Laminar Boundary Layer. Craig M. Schmidt and Arnold J. Hanawalt. *J. Aero. Sci.*, Jan., 1957, pp. 73, 74.

Papers on Heat Transfer and Unsteady Aerodynamics. I—Integral Methods for Laminar Forced Convection Calculations–An Evaluation of Two Approaches, Jacques A. F. Hill. **II—A Further Note on Aerodynamic Heating,** Morton Finston. **III—The Binary Mixture Boundary Layer Associated with Mass Transfer,** Judson R. Baron. **IV—Experiments in Unsteady Aerodynamics Leading to the Development of an Acoustic Drag Coefficient.** Eugene S. Rubin and Edward M. Kerwin, Jr. (*Appl. Mech., 9th Internatl. Cong., Brussels, Sept. 5–13, 1956.*) *MIT NSL TR 179*, 1956. 59 pp. 30 refs.

Inversion of the Prandtl-Meyer Relation for Specific Heat Ratios of 5/3 and 5/4. Ronald F. Probstein. *Brown U., Div. Eng., USAF WADC TN 56-497* [*AD 110580*], Nov., 1956. 12 pp. Analysis using an inversion of the usual form of the Prandtl-Meyer relation for an isentropic supersonic flow with constant specific-heat ratio.

One-Dimensional Unsteady Flow of Magneto-Gasdynamics. S. I. Pai. *U. Md., Inst. Fluid Dynamics & Appl. Math. TN BN-86* (*AFOSR TN 56-537*)[*AD 110356*], Nov., 1956. 14 pp. Analysis of

AC's NEW INERTIAL GUIDANCE SYSTEM—

the achiever...

more intricate than a chronometer...infinitely more accurate!

Even a chronometer need not be engineered down to the millionths-inch tolerances held in the AC Achiever—new inertial guidance system now in development at AC's Milwaukee plant.

Unbelievable accuracy makes the Achiever one of the most important new guidance systems in America's arsenal of defense. What's more, this remarkable new device cannot be diverted from its course by radio or radar jamming or any other similar method.

All this is thanks to a new concept in gyroscopic control and inertial guidance with a new-type gyro stabilization of uncanny precision, a phase of AC's current work as a prime contractor to the Air Force.

AC's engineers are eminently qualified to take the most complex problems from the "dream stage" straight through final production. Because of this competence, they know that, for them, the future represents "Opportunities Unlimited"!

GM GENERAL MOTORS

AC

THE ELECTRONICS DIVISION OF GENERAL MOTORS

FLINT, MICHIGAN • MILWAUKEE, WISCONSIN

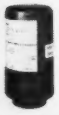
GYROS
for every application

For hours in aircraft or minutes in missiles, gyros must possess ruggedness and dependability that will assure performance of the mission. Kearfott Gyros possess this ruggedness and dependability coupled with extremely high accuracy. That is why they are so widely used in all types of aircraft and missiles. Kearfott Vertical, Rate, Free, Directional and Floated Rate Integrating Gyros as well as Stable Elements are designed to meet the most stringent airborne requirements.

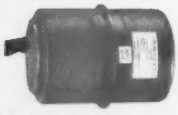
Unsurpassed in Performance Unequalled in Compactness

Kearfott Miniature Vertical Gyros satisfy the requirements of MIL-E-5272 as regards shock test (Procedure II) humidity, salt spray, fungus resistance, rain, sand, dust, immersion and explosion proof. Duplicates the performance of standard vertical gyros in ½ the volume and weight.

FREE GYRO



RATE GYRO



FLOATED RATE INTEGRATING GYRO

3 GYRO PLATFORM

Write today for technical data on Kearfott Gyros.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Kearfott

A SUBSIDIARY OF GPE

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

the unsteady flow of a viscous, heat conducting, electrically conducting, and compressible gas under planar magnetic field perpendicular to the velocity vector.

Oblique-Shock Relations at Hypersonic Speeds for Air in Chemical Equilibrium. W. E. Moeckel. *U.S., NACA TN 3895*, Jan., 1957. 18 pp. Calculation of oblique-shock relations for flight velocities up to 25,000 ft./sec. at altitudes up to 200,000 ft.

Stagnation Point Heat Transfer for Hypersonic Flow. Mary F. Romig. *Jet Propulsion*, Dec., 1956, pp 1,098–1,101. Derivation of an equation which introduces real gas effects through a reference enthalpy and a fitted curve for stagnation-point velocity gradient.

Simplified Method for Estimating Compressible Laminar Heat Transfer with Pressure Gradient. Eli Reshotko. *U.S., NACA TN 3888*, Dec., 1956. 16 pp. Application of an approximation to the method of Cohen and Reshotko in order to simplify the calculation of laminar heat transfer.

Boundary Layer

Note on Wada's Method of Solving the Laminar Boundary Layer Equations. Tetsushi Okamoto. *Tokyo Inst. Tech., Bul., Ser. B*, No. 1, 1956, pp. 25, 26. Discussion of Wada's assumptions in which the displacement thickness is taken as equal to the thickness of the boundary layer.

The Shear Flow Along a Flat Plate with Uniform Suction. Takeo Sakurai. *J. Aero. Sci.*, Jan. 1957, p. 79. Analysis presenting an exact solution of the Navier-Stokes equations which represent the boundary layer along an infinite flat plate with uniform suction situated in a shear flow.

Average Properties of Compressible Laminar Boundary Layer on Flat Plate with Unsteady Flight Velocity. Appendix A, B—**Determination of Integrals for Harmonic Oscillations.** Franklin K. Moore and Simon Ostrach. *U.S., NACA TN 3886*, Dec., 1956. 35 pp. Theoretical investigation to determine the time-average characteristics in nearly quasi-steady flow for boundary layers over either insulated or isothermal plates.

Second Approximation to the Laminar Boundary-Layer Flow Over a Flat Plate. Isao Imai. *J. Aero. Sci.*, Feb., 1957, pp. 155, 156. ONR-supported analysis including calculation, by means of the theorem of momentum, of the total skin friction acting on the portion of the plate of length x from the leading edge.

Laminar Boundary Layers on Moving Walls. Stanley H. Smith. *Cornell U. Grad. Sch. Aero. Eng. Rep.* (*AFOSR TN 56-454*)[*AD 96800*], Sept., 1956. 47 pp. Theoretical investigation into the nature of the boundary layer on a wall moving with a constant velocity. A solution of von Kármán's momentum equation is derived.

Laminar Boundary Layer on a Spinning Circular Cone in Supersonic Flow at a Small Angle of Attack. Martin Fiebig. *Cornell U. Grad. Sch. Aero. Eng. Rep.* (*AFOSR TN 56-532*) [*AD 110351*], June, 1956. 61 pp. 14 refs. Development of the compressible laminar-boundary equations for bodies of revolution; application of these equations to the case of a rotating

World's Fastest Navy Fighter

9 Proudly wears Sargent controls

Nine Sargent quality units have been selected to provide Chance Vought's F8U-1 Crusader with instantaneous, positive, feathertouch response.

These units, Sargent fabricated to Vought specifications, provide a system for control for the safe, positive, efficient operation of this great fighter.

The experience of more than 36 years of design and manufacture of precision equipment systems has given Sargent Engineering Corporation the "know-how" to aid in solving the essential and advance problems of force control. Leading airframe and missile manufacturers are using hundreds of different Sargent hydraulic, mechanical, pneumatic, electrical and electronic force control units on the nation's military planes, commercial planes and missiles.

Sargent places its facilities of design and manufacture at your disposal. We invite you to send your specifications for the Sargent proposal of your force control problems.

Since 1920

ENGINEERING CORPORATION

2533 EAST 56th STREET
HUNTINGTON PARK, CALIFORNIA

BUILDS QUALITY THAT BUILDS GOOD WILL

...ndard ...rvellance

...D WILL" ... dispo... pleased ... return ... the place ... has been ...ell treated.
— U.S. Supreme Court

Sargent

cone in supersonic flow at angle of attack; and derivation of a perturbation solution.

The Boundary Layer Inside a Conical Surface Due to Swirl. H. E. Weber. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14-16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 587–592. Theoretical investigation to derive the momentum integrals of the boundary layer and to obtain numerical solutions for both the laminar and turbulent boundary layer. Flow in the free stream is assumed to be a potential vortex. Analytical results are compared to experimental data obtained by using the particle paths on the conical surface of a cyclone dust separator.

Discussion of the Influence of Confining Surfaces Upon the Boundary Layer in a Channel. Ralph Burton. *J. Aero. Sci.*, Feb., 1957, pp. 149, 150.

Bemerkung zu den "ähnlichen" instationären laminaren Grenzschichtströmungen. Theo Geis. *ZAMM*, Sept.-Oct., 1956, pp. 396–398. In German. Evaluation of "similar," laminar, nonstationary boundary layers.

An Experimental Investigation of Leading-Edge Shock-Wave - Boundary-Layer Interaction at Mach 5.8. James M. Kendall, Jr. (*IAS 24th Annual Meeting, New York, Jan. 23–26, 1956, Preprint 611.*) *J. Aero. Sci.*, Jan., 1957, pp. 47–56. 18 refs.

Über eine Hypothese, die den Mechanismus der Turbulenz-Entstehung betrifft. U. Domm. *DVL Bericht No. 23*, Sept., 1956. 15 pp. 26 refs. Westdeutscher Verlag, Köln & Opladen. In German. The stability of a vortex street is analyzed for the case of boundary layer over a flat plate, and a discussion of a hypothesis related to the mechanism of turbulence formation is included. Reynolds and Rayleigh approach is used to study the laminar-turbulent transition.

Boundary Layer Measurements on 10° and 20° Cones at M = 2.45 and Zero Heat Transfer. Appendix I—**The Laminar Boundary Layer (Approximate Algebraic Solutions).** Appendix II—**A Comparison Between Turbulent Boundary Layers on a Cone and a Flat Plate Based on a Log Law Analysis.** Appendix III—**A Summary of Young's Correlation Between the Turbulent Boundary Layers for 2 Dimensional and Axi-Symmetric Flow Extended to the Cone-Flat Plate Case.** Appendix IV—**Some Empirical Relations Between the Turbulent Boundary Layer Characteristics for Flow Over Cones and Flat Plates.** Appendix V—**Corrections to the Experimental Data Due to Differences in Mach Number Between the Cones and Flat Plate.** F. V. Davies and J. R. Cooke. (*Gt. Brit., RAE TN Aero.2314*, Nov., 1954.) *Gt. Brit., ARC CP 264*, 1956. 63 pp. 14 refs. BIS, New York, $1.53. Test results which show that transitions from laminar to turbulent flow occur between 4 and 6 in. from the tip of a 10° cone at a Reynolds Number between 10^6 and 1.4×10^6; the layer on the 20° cone is laminar over its length of 6 in. up to a Reynolds Number of 1.4×10^6.

Boundary Layer Separation in Two-Dimensional Supersonic Flow. G. E. Gadd and D. W. Holder. *Gt. Brit., ARC CP 270* (Mar. 21, 1955), 1956. 8 pp. 22 refs. BIS, New York, $0.45. Discussion of boundary-layer separation in supersonic flow which shows fairly sharp increase in pressure before separation.

The Effects of Convex Surface Curvature on Boundary Layer Separation in Supersonic Flow. Appendix—**Theoretical Analysis of the Direct Effect of Surface Curvature on Laminar Separation.** G. E. Gadd. *Gt. Brit., ARC CP 289* (Nov. 26, 1955), 1956. 16 pp. BIS, New York, $0.45. Theoretical and experimental investigation.

Displacement Thickness of the Unsteady Boundary Layer. Franklin K. Moore and Simon Ostrach. *J. Aero. Sci.*, Jan., 1957, pp. 77, 78. Analysis extending previous investigations on the displacement effect of a three-dimensional boundary layer to the unsteady boundary-layer case. The results are also applied to certain flows for which unsteady boundary-layer solutions are available.

A New Method for the Solution of a Differential Equation with Two-Point Boundary Conditions Applied to the Compressible Boundary Layer on a Yawed Infinite Wing. L. F. Crabtree and E. R. Woollett. *J. RAeS*, Dec., 1956, pp. 808, 809.

Subsonic Boundary-Layer Transition Caused by Single Roughness Elements. J. Leith Potter. *J. Aero. Sci.*, Feb., 1957, pp. 158, 159.

Experimental Determination of the Critical Heights of Surface Irregularities. E. H. Cowled. *Australia, ARL AN 138*, Nov., 1954. 21 pp. 13 refs. Transition tests using five types of surface irregularity and paying particular attention to the influence of shape on the critical heights of isolated disturbances. Investigation includes experiments to determine the effect of several irregularities arranged in a chordwise row and discussion of the problem of correlating data by different experimental methods.

L'Aspiration de la Couche Limite en Technique Aéronautique. H. Schlichting. *Tech. et Sci. Aéronautiques*, No. 4, 1956, pp. 149–161. 26 refs. In French. Application of boundary-layer suction to develop methods for improving aerodynamic airfoil characteristics.

Flow Around Orifice Utilized for Injection or Suction of Fluid. Tetsushi Okamoto and Fusao Mikami. *Tokyo Inst. Tech., Bul, Ser. B*, No. 1, 1956, pp. 17–24. Analysis of the problems of sweat cooling and boundary-layer control, treating the flow around an orifice as the flow around a rectangular groove which has sources or sinks on its bottom surfaces.

Quelques Aspects Physiques du Soufflage sur les Ailes d'Avion. Ph. Poisson-Quinton. *Tech. et Sci. Aéronautiques*, No. 4, 1956, pp. 163–195. 33 refs. In French. Extensive review of the literature pertaining to the mechanism of blowing for boundary-layer control.

Investigation of the Effectiveness of Boundary-Layer Control by Blowing Over a Combination of Sliding and Plain Flaps in Deflecting a Propeller Slipstream Downward for Vertical Take-Off. Kenneth P. Spreemann and Richard E. Kuhn. *U.S., NACA TN 3904*, Dec., 1956. 44 pp. Tests in a static-thrust facility at the Langley Aeronautical Laboratory. Investigation takes into account the effects of a leading-edge slat, ground proximity, end plate, and propeller position.

Control Surfaces

The Mechanism, Causes and Cures of Transonic Control-Surface Buzz. A. MacLellan. *Aero Dig.*, Dec., 1956, pp. 30, 32, 34. Definition of the problem, presentation of a criterion for minimum control-system stiffness, discussion of buzz in the case of an airplane with a mechanical control system, and evaluation of four possible cures.

The Lift Coefficient of a Thin, Jet-Flapped Wing. D. A. Spence. *Proc. Royal Soc. (London), Ser. A*, Dec. 4, 1956, pp. 46–68. 15 refs. Derivation of a solution for the inviscid, incompressible flow past a thin, two-dimensional wing at a small incidence, at the trailing edge of which a thin jet emerges at a small deflection.

Wind-Tunnel Investigation of Jet-Augmented Flaps on a Rectangular Wing to High Momentum Coefficients. Vernard E. Lockwood, Thomas R. Turner, and John M. Riebe. *U.S., NACA TN 3865*, Dec., 1956. 51 pp. Test results for a jet of air blown backward through a small gap, tangentially to the upper surface of a round trailing edge, and separated from the trailing edge at various angles up to 110° with respect to the wing chord line.

Wind-Tunnel Investigation at Low Speeds to Determine the Effect of Aspect Ratio and End Plates on a Rectangular Wing with Jet Flaps Deflected 85°. John G. Lowry and Raymond D. Vogler. *U.S., NACA TN 3863*, Dec., 1956. 21 pp. Tests conducted with momentum coefficients as high as 17.5.

Wind-Tunnel Investigation of an External-Flow Jet-Augmented Slotted Flap Suitable for Application to Airplanes with Pod-Mounted Jet Engines. John P. Campbell and Joseph L. Johnson, Jr. *U.S., NACA TN 3898*, Dec., 1956. 47 pp. Experiments including tests of an unswept wing and of a swept-wing jet transport or bomber model, and using compressed-air jets exhausting from nozzles attached to the lower surface of the wings to simulate the jets from pod-mounted jet engines.

Fans

Performance of Sheet Metal Bladed Ducted Axial Flow Fans. R. A. Wallis. *Australia, ARL Rep. A.90*, Sept., 1954. 71 pp. 19 refs. Test results which show that a relatively good efficiency can be obtained with a circular air fan. The order of the tail-fairing losses has been established, and a design example is presented.

Selection Chart—Propeller Fans. Anwar A. Atalla. *Design News*, Jan. 1, 1957, pp. 112, 113. Chart to provide blade-tip diameter and blade-pitch angle for known airflow rate and static pressure.

A Preliminary Report on the Design and Performance of Ducted Windmills. G. M. Lilley and W. J. Rainbird. *Coll. of Aeronautics, Cranfield, Rep. 102*, Apr., 1956. 72 pp. 17 refs. Study of the theoretical gain in power output obtained with a fully ducted land-type windmill as compared with the standard unshrouded-type windmill. The design of the internal and external ducting is discussed together with its effects on the overall performance of the windmill.

TRAIL BLAZING – Many frontiers of science have been charted by Northrop Aircraft engineers and scientists in seventeen years of research and development of manned and pilotless aircraft. Northrop Snark SM-62s, first intercontinental guided missiles to be disclosed by the U. S. Air Force, are now flying from the Florida coast over the USAF missile test range. Northrop's newest trail blazer is a supersonic trainer designed to help pilots master the complexities of tomorrow's combat aircraft. Other Northrop trail blazers include Scorpion F-89 interceptors; pilotless target aircraft and missiles from Northrop's subsidiary, Radioplane Company; ground support and armament equipment from the Anaheim Division; and entirely new concepts of integrated weapon systems which are constantly being initiated to improve our national defense.

NORTHROP

NORTHROP AIRCRAFT, INC. • HAWTHORNE, CALIFORNIA

Pioneers in All Weather and Pilotless Flight

Fluid Mechanics & Aerodynamic Theory

The One-Dimensional and Two-Dimensional Gas Dynamics Analogies. R. A. A. Bryant. *Australian J. Appl. Sci.*, Dec., 1956, pp. 296–313. 20 refs. Study of an analogy between high-speed gas flow and shallow open-channel flow to determine the possibility of using it for the investigation of two-dimensional transonic flow.

The Similarity Rules for Second-Order Subsonic and Supersonic Flow. Milton D. Van Dyke. *U.S., NACA TN 3875*, Jan., 1957. 20 pp. 11 refs. Extension of Göthert's similarity rule—and its supersonic counterpart—for linearized compressible-flow theory.

Preliminary Considerations, Improved Free-Volume Theory of Liquids. II. John S. Dahler and J. O. Hirschfelder. *U. Wis. NRL Dept. Chem. TR WIS-AF-5*, Dec. 5, 1956. 12 pp. Re-evaluation of a previously presented cell theory of liquids. A more direct method arising from the spherical symmetrization of Kirkwood's integral equation is used. There is a simplification in the integral equation for the distribution function and the subsequent calculation of the equation of the state and thermodynamic properties.

The Speed of Drifting Bodies in a Stream. J. R. D. Francis. *J. Fluid Mech.*, Nov., 1956, pp. 517–520. Theoretical and experimental investigation with results indicating that the speed of free-floating bodies on the surface of a water stream in a sloping channel is essentially the same as the mean speed of the layer of water in which the bodies are floating.

On the Motion of Small Spheroidal Particles in a Viscous Liquid. P. G. Saffman. *J. Fluid Mech.*, Nov., 1956, pp. 540–553. 11 refs.

Die hydrodynamischen Verhältnisse in Gaswirbelschichten auf Grund von Wärmeübergangsmessungen. F. Fetting. *VDI Zeitschrift*, Oct. 11, 1956, pp. 1,692, 1,693. In German. Determination of hydrodynamic characteristics of the vortex layer, based on heat-transfer measurements.

The Design of Axial Flow Pumps. R. D. Bowerman. (*Trans. ASME*, Nov., 1956, pp. 1,723–1,734.) *CIT Hydrodynamics Lab. Rep. E-19.10*, Apr., 1956. 12 pp. 10 refs. ONR-supported description of a procedure for the design of axial-flow pump impellers that takes induced interference effects into account in the prediction of performance.

Aerodynamic Characteristics of a Circular Cylinder at Mach Number 6.86 and Angles of Attack up to 90°. Jim A. Penland. *U.S., NACA TN 3861*, Jan. 1957. 32 pp. 12 refs. Pressure-distribution and force tests in the Langley 11-in. hypersonic tunnel. Results are compared with the Grimminger-Williams-Young hypersonic approximation, with a simple modification of the Newtonian flow theory, and data obtained at a lower Mach Number.

Stagnation Point of a Blunt Body in Hypersonic Flow. Ting-Yi Li and Richard E. Geiger. (*IAS 24th Annual Meeting, New York, Jan. 23–26, 1956, Preprint 629.*) *J. Aero. Sci.*, Jan., 1957, pp. 25–32.

Incompressible Flow Around a Rectangular Protuberance or Groove on a Plane Boundary. Tetsushi Okamoto and Fusao Mikami. *Tokyo Inst. Tech., Bul., Ser. B*, No. 1, 1956, pp. 7–15. Calculation of the pressure distribution and the streamlines around a rectangular protuberance for two-dimensional incompressible flow.

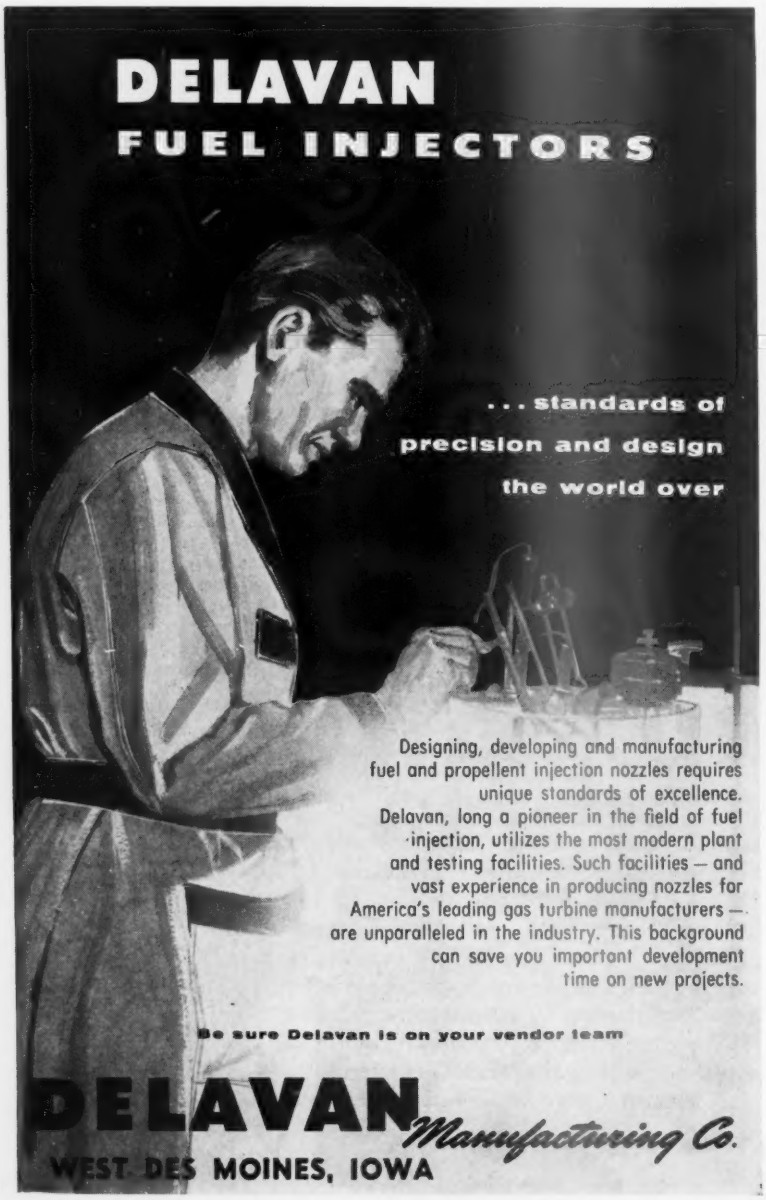
Three-Dimensional Vortex Pattern Behind a Circular Cylinder. Francis R. Hama. *J. Aero. Sci.*, Feb., 1957, pp. 156–158. OSR-supported towing-tank investigation.

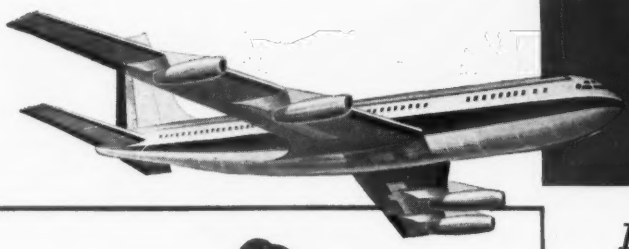
A Proposal Concerning Laminar Wakes Behind Bluff Bodies at Large Reynolds Number. G. K. Batchelor. *J. Fluid Mech.*, Oct., 1956, pp. 388–398. Study of a model of steady flow about a bluff body at large Reynolds Number which is different from the Helmholtz and Kirchhoff classical free-streamline model.

Minimum-Drag Ducted and Closed Three-Point Body of Revolution Based on Linearized Supersonic Theory. Hermon M. Parker. *U.S., NACA TN 3704*, Dec., 1956. 20 pp. Derivation of a solution without resort to slender-body approximations. Analysis includes complete calculations for the special case of a closed body with a given section (the third point) at the mid-body position.

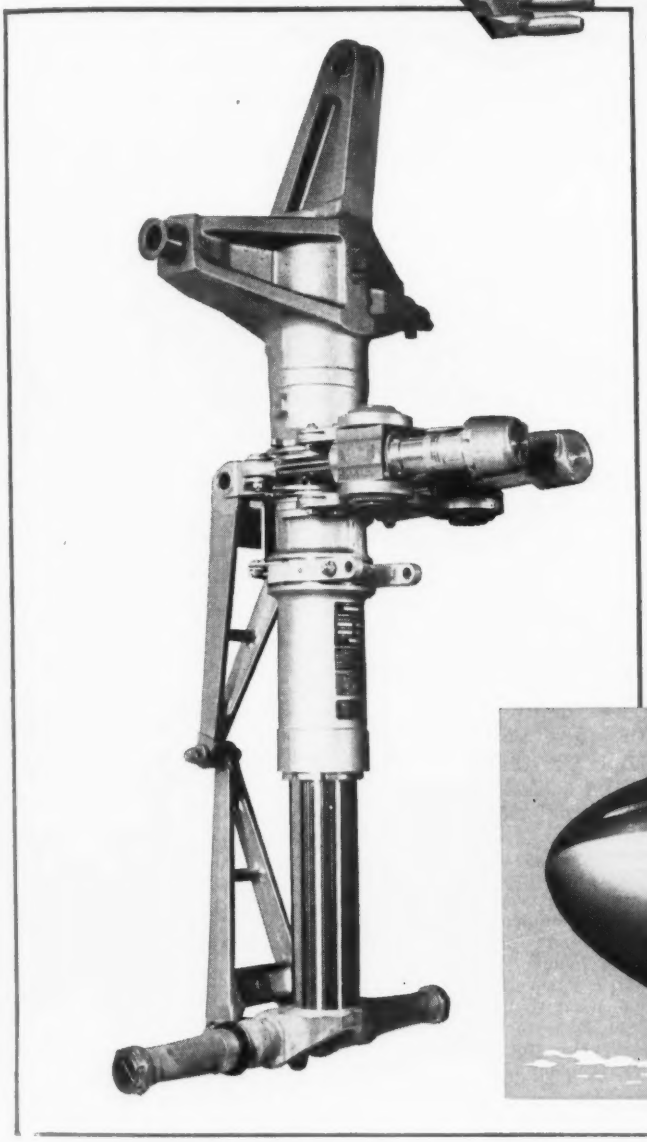
On the Drag of Slender Bodies at Sonic Speed. Sune B. Berndt. *Sweden, Flygtekniska Försöksanstalten, FFA Medd. 70*, 1956. 17 pp. Investigation of how the difference in nonviscous drag depends upon the difference in cross-sectional shape of equivalent bodies.

Experiments on Cone Drag in a Rarefied Air Flow. D. C. Ipsen. *Jet Propul-*


DELAVAN
FUEL INJECTORS
. . . standards of
precision and design
the world over
Designing, developing and manufacturing fuel and propellent injection nozzles requires unique standards of excellence. Delavan, long a pioneer in the field of fuel injection, utilizes the most modern plant and testing facilities. Such facilities — and vast experience in producing nozzles for America's leading gas turbine manufacturers — are unparalleled in the industry. This background can save you important development time on new projects.
Be sure Delavan is on your vendor team
DELAVAN Manufacturing Co.
WEST DES MOINES, IOWA



Why Choose menasco ?

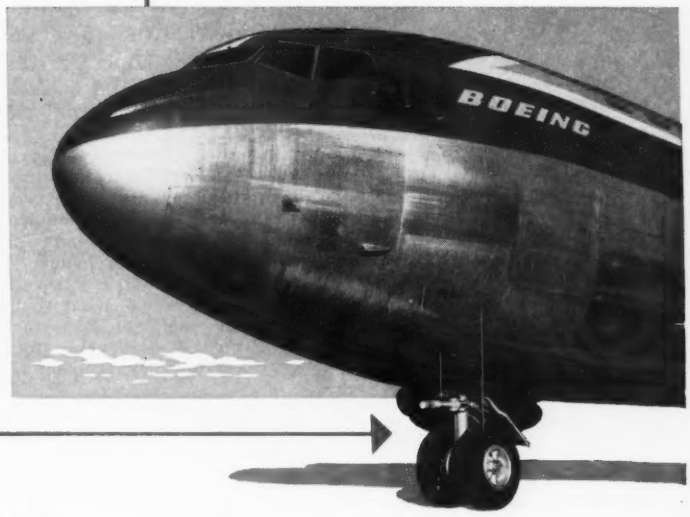


Because MENASCO QUALITY MEETS ALL STANDARDS

America's first great jet transports, the 707 Stratoliner and the Intercontinental will provide new luxury, distance-devouring speed and unimagined smoothness of takeoff, flight and landing. Their military counterpart, the KC-135 Tanker, will make possible global operation of another great *BOEING* aircraft, the B-52 jet bomber. These airplanes represent another outstanding *BOEING* contribution to aviation.

In selecting *MENASCO* to build the nose landing gear for its 707 series transports and its KC-135 Tanker, *BOEING* was assured that this vital component would meet the exacting requirements of either the Air Force or the Civil Aeronautics Administration. *MENASCO'S quality is "built-in" and meets any and all standards.*

MENASCO precision fabrication of this *BOEING* design combines the most effective application of both steel and aluminum for lighter weight and compactness, and the exclusive *Uniwelding* process assures greater strength and reliability.



First in development, quality, delivery and service

menasco manufacturing company

805 San Fernando Boulevard, Burbank, California

SPECIALISTS IN AIRCRAFT LANDING GEAR

sion, Dec., 1956, pp. 1,076, 1,077. Investigation on a cone of 15° half-angle conducted over a range of Reynolds Numbers from 70 to 1,500 at $M = 2$, and 500 to 7,000 at $M = 4$.

Supersonic Flow Past a Bluff Body with a Detached Shock. I—Two-Dimensional Body. W. Chester. *J. Fluid Mech.*, Oct., 1956, pp. 353–365. Analysis of flow at high Mach Number past a body with a rounded nose, neglecting viscosity and heat conduction. The body is assumed to be two-dimensional and symmetrical about an axis parallel to the incident stream.

Supersonic Flow Past a Bluff Body with a Detached Shock. II—Axisymmetrical Body. W. Chester. *J. Fluid Mech.*, Nov., 1956, pp. 490–496. Theoretical investigation to derive expressions for the distance between the body and the shock, the radius of curvature of the shock compared with that of the body, and the pressure distribution on the body.

Supersonic Rotational Flow Around a Sharp Corner on a Body of Revolution. Hung-Ta Ho and Maurice Holt. *Brown U. Div. Eng., USAF WADC TN 56-394 [AD 97273]*, Sept., 1956. 22 pp. Theoretical investigation of the singularity arising at the shoulder in the case of uniform hypersonic flow past a cone cylinder with detached bow wave. Analysis is carried out by means of series expansions in powers of the distance from the shoulder with coefficients depending on the angular coordinate based on the shoulder.

Un Metodo Generale per lo Studio del Campo Supersonico Dietro Onda d'Urto Aderente. Luigi Broglio. *Cen. Consult. Stud. e Ric. Aero. Mil., Ser. I*, June, 1956. 74 pp. In Italian. ARDC-supported development of a method for studying the flow region behind a shock wave attached to the leading edge of a body of given shape.

A Theory for Base Pressures in Transonic and Supersonic Flow. H. H. Korst. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 593–600. 15 refs. Derivation of a unique and stable solution for the base pressure from analysis of a physical flow model based on the concepts of interaction between the dissipative shear flow and the adjacent free stream and on the conservation of mass in the wake. Four flow components are integrated in the model: the flow approaching the trailing edge, the expansion around the trailing edge, the mixing within the free-jet boundary, and the recompression at the end of the wake. Analysis emphasizes the case of isoenergetic constant-pressure mixing in the turbulent free-jet boundary, and agreement is found between theory and experimental data.

Transonic Flow Past the Two-Dimensional Wedge with Detached Shock Wave. II. Akira Takano. *J. Japan Soc. Aero. Eng.*, Nov., 1956, pp. 8–14. Analysis of the boundary-value problem for the small perturbed function due to angle of attack, taken from the basic solution at zero angle of attack presented previously. Irrotational and inviscid flow is assumed in the whole region, and the small region of separation at the leading edge is ignored.

On the Theory of Hypersonic Flow Past Plane and Axially Symmetric Bluff Bodies. N. C. Freeman. *J. Fluid Mech.*, Oct., 1956, pp. 366–387. 10 refs. Derivation of a solution for hypersonic flow using boundary-layer techniques together with the von Mises variables x and ψ. The ratio of the specific heats is constant and equal to unity. A method of successive approximations is used when $\epsilon = (\gamma - 1) \times (\gamma + 1)$ and the free-stream Mach Number is infinite. Formulas for the streamlines, shock shape, and pressure distribution are derived.

The Method of Characteristics for Steady Supersonic Rotational Flow in Three Dimensions. Maurice Holt. *J. Fluid Mech.*, Oct., 1956, pp. 409–423.

The Almost-Rigid Rotation of Viscous Fluid Between Concentric Spheres. Ian Proudman. *J. Fluid Mech.*, Nov., 1956, pp. 505–516. Theoretical investigation to exemplify, in terms of a simple mathematical model, the properties of the secondary flow induced by the viscous stresses over the boundaries of two concentric spheres rotating rapidly, at large Reynolds Numbers, about the same axis with slightly different angular velocities.

The Refraction of Shock Waves at a Gaseous Interface. Robert G. Jahn. *J. Fluid Mech.*, Nov., 1956, pp. 457–489. Shock-tube experiments using interferograms of configurations resulting from the impingement of weak and fairly strong shocks, at various angles, on interfaces between air/CO_2 and air/CH_4 to measure the strengths of the reflected waves and the angles of refraction. Measurements are compared with Polachek and Seeger's theoretical results.

Colonial's "SILICOL"

SILICONE RUBBER

can meet your "TOUGHEST" aircraft parts requirements

We Regularly Compound and Mold Silicone Rubber Parts For:

HEAT RESISTANCE — up to 700° F.
COLD RESISTANCE — down to —130° F.
CHEMICAL RESISTANCE — over 600°F. range
DIELECTRIC PROPERTIES — as required
STRENGTH COMBINATIONS — tear, tensile, elongation

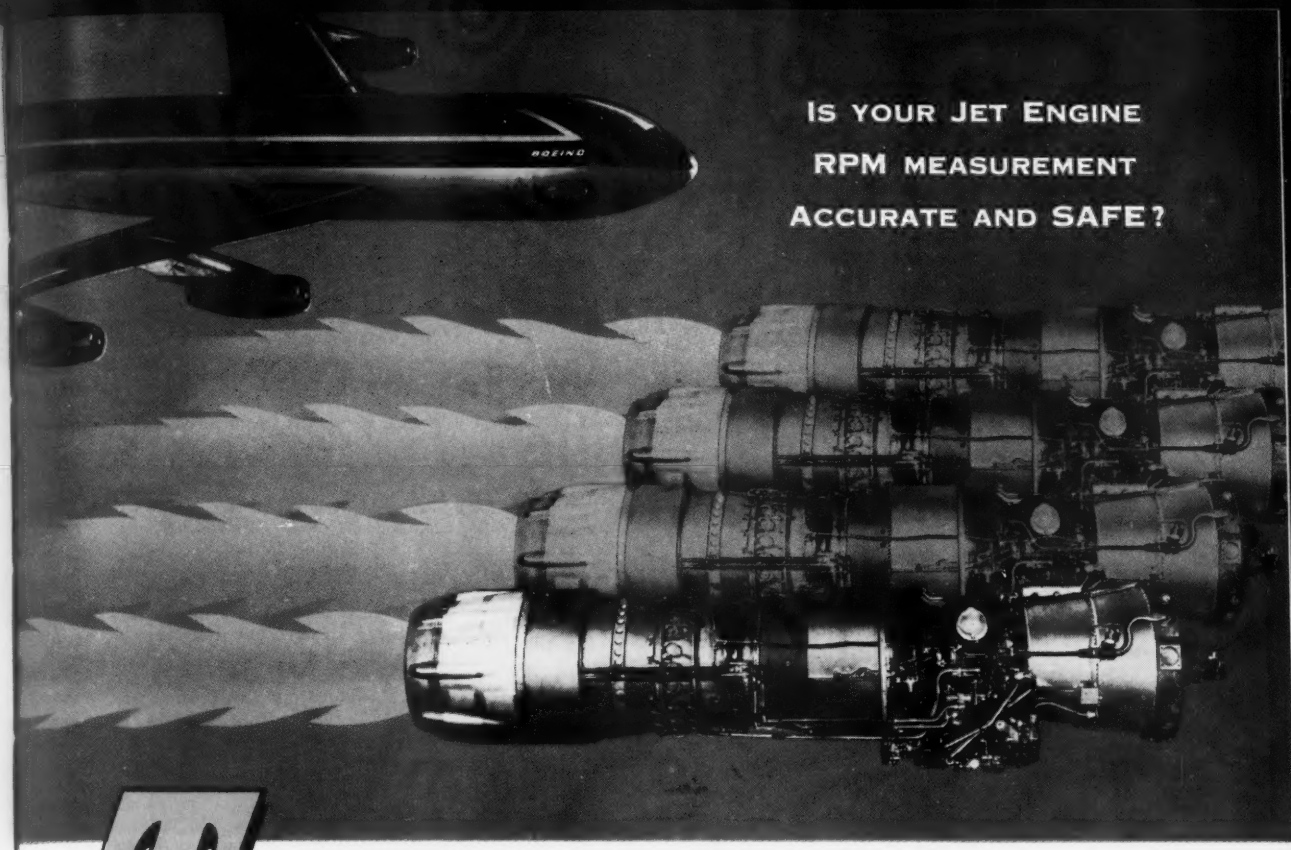
Colonial Rubber Company can compound versatile silicone rubber to obtain virtually any property, or combination of properties the aircraft industry may require of a rubber part. If your rubber parts problem is one of compound development, parts production or both, contact us. We have a long background of industrial rubber experience, plus complete laboratory and plant facilities to meet your "toughest" requirements efficiently, economically and dependably.

OUR BROCHURE

illustrates and gives full details on Colonial's service in custom compounding and molding of rubber and silicone rubber. Write for your copy today. No obligation.

1986-1

COLONIAL RUBBER CO.
RAVENNA, OHIO



IS YOUR JET ENGINE RPM MEASUREMENT ACCURATE AND SAFE?

TAKCAL®

READS JET ENGINE SPEED to GUARANTEED ACCURACY of 10 RPM in 10,000 RPM (±0.1%)

The inter-relation of RPM to efficiency and thrust in jet engines is fundamental. Proper adjustments for maximum thrust, maximum engine life and maximum safety of operation can be made only upon accuracy of instrumentation. The TAKCAL tests to guarantee that accuracy.

The new B & H TAKCAL incorporates a refinement of the frequency meter principle. It operates in the low (0 to 1000 cps) range, reading the frequency of the tachometer generator on a scale calibrated in percent RPM corresponding to the engine's RPM. It reads engine speed while the engine is running with a guaranteed accuracy of ±0.1% in the range of 0 to 110% RPM. Additionally, the TAKCAL circuit can be used to trouble-shoot and isolate errors in the aircraft tachometer system, with the circuit and tachometer paralleled to obtain simultaneous reading.

The TAKCAL's component parts are identical with those used in the J-Model JETCAL Analyzer. They are here assembled as a separate unit tester and for use with all earlier models of the JETCAL Tester.

The TAKCAL operates accurately in all ambient temperatures from −40°F. to 140°F. Low in cost for an instrument of such extreme accuracy, it is adaptable to application in many other fields.

For full information write or wire . . .

CHECKS TACHOMETER "SYSTEM" ACCURACY. ADAPTS TO ANY FREQUENCY PROBLEM!

Explosion-proof TAKCAL for special applications. Measures 200 to 7500 RPM, direct reading, with ±0.1% accuracy.

B & H makes the *JETCAL*® Analyzer and *TEMPCAL*® Tester

B & H INSTRUMENT CO., INC.

3479 West Vickery Blvd. • Fort Worth 7, Texas

Sales-Engineering Offices:

VALLEY STREAM, N. Y.: 108 So. Franklin, LO 1-9220 • DAYTON, OHIO: 209 Commercial Bldg., MI 4563 • EL SEGUNDO, CAL.: 427 E. Grand Ave., EA 2-1644

Fairchild Engine Division and Gas Turbine Laboratory present IMPORTANT ENGINEERING POSITIONS

Fairchild Engine Division is now expanding its engineering staffs in its plant and Gas Turbine Laboratory at Deer Park, Long Island, New York.

Investigate these positions:

MECHANICAL DESIGN ENGINEERS

For mechanical design of turbojet engines and components, and to conduct preliminary design study investigations on gas turbine engines.

MECHANICAL DESIGN ANALYTICAL ENGINEERS

To work closely with design engineers and to make recommendations as a result of analytical studies, with respect to stress analysis of lightweight rotating machinery, vibration, analysis, cycle analysis investigations, analysis of mechanical component functionings and general structural problems.

RESEARCH ENGINEERS

Advanced degree, preferably in the fields of applied physics, chemistry, aerodynamics or applied mechanics. Also: engineers with supersonic aerodynamics background with high speed aircraft or wind tunnel testing.

AIRCRAFT SYSTEMS ANALYSIS

Mission analysis for aircraft systems. Familiar with engine-airframe mission analysis for modern aircraft.

TEST AND DEVELOPMENT ENGINEERS

Aeronautical and mechanical engineers to plan, supervise and conduct development test programs with gas turbine engines and components.

EQUIPMENT ENGINEERS

Familiar with mechanical test equipment design, including high speed rotating machinery and equipment.

ENGINE VIBRATIONS ENGINEERS

To determine means of measuring stress and shock loads in test articles. Area of operations is concerned with turbine engine vibration characteristics associated with high speed rotating parts subject to high temperatures and high stress loads.

COMPRESSOR DESIGNERS

TURBINE DESIGNERS • FIELD ENGINEERS

And, engineers with experience in other allied mechanical or aeronautical fields such as:

Instrumentation Engineers; Performance Analytical Engineers; Engine Controls Engineers; Equipment and Product Drafting Checkers, and Mechanical Design Layout Men.

Please Contact Felix Gardner

FAIRCHILD

ENGINE DIVISION • DEER PARK, L. I., N. Y.

A Division of Fairchild Engine and Airplane Corporation

...WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS!

An Experiment of Location of Detached Shock Wave Ahead of Wedge Profile by Hydraulic Analogy. Tetsushi Okamoto. *Tokyo Inst. Tech., Bul., Ser. B,* No. 1, 1956, pp. 1–5. Investigation in a flowing water channel to check the validity of Laitone's theory in the case of a wedge with large nose angle.

Method for Calculating Effects of Dissociation on Flow Variables in the Relaxation Zone Behind Normal Shock Waves. John S. Evans. *U.S., NACA TN 3860,* Dec., 1956. 52 pp. 14 refs. Derivation of generalized expressions and presentation of charts for the temperature, pressure, density, and flow velocity behind a shock wave. These charts depend on the shock Mach Number, the initial state of the gas, and an enthalpy parameter.

Properties of the Shock Transition at Low Temperature. J. J. Gilvarry. *J. Appl. Phys.,* Dec., 1956, pp. 1,467–1,472. 21 refs. Formulation, in general terms, of the low-temperature thermodynamic functions of a degenerate substance possessing a zero-point pressure (or energy). The formation is applicable to the Fermi-Dirac gas, the Thomas-Fermi atom, the Debye solid, and the Mie-Grüneisen solid as special cases.

On Supersonic Flow Behind a Curved Shock. R. E. Meyer. *Australia, ARL Rep. A.98,* Aug. 1956. 11 pp. Derivation of an approximate solution for the flow of an inviscid perfect gas. The method accounts for the vorticity and entropy gradients to a first approximation.

An Inequality Concerning the Production of Vorticity in Isotropic Turbulence. R. Betchov. *J. Fluid Mech.,* Nov., 1956, pp. 497–504. Theoretical and experimental investigation to determine the largest rate of vorticity production compatible with isotropy, homogeneity, and compressibility requirements.

Outline of a Theory of Turbulent Shear Flow. W. V. R. Malkus. *J. Fluid Mech.,* Nov., 1956, pp. 521–539. Analysis of the spatial variations and spectral structure of steady-state turbulent shear flow in channels, without the introduction of experimental parameters.

Über die Wirbelstrassen von geringster Instabilität. U. Domm. *ZAMM,* Sept.-Oct., 1956, pp. 367–371. In German. Analysis indicating that two-parameter vortex streets, treated originally by Maue and Dolaptschiew, are unstable with respect to a two-group perturbation according to Schmieden.

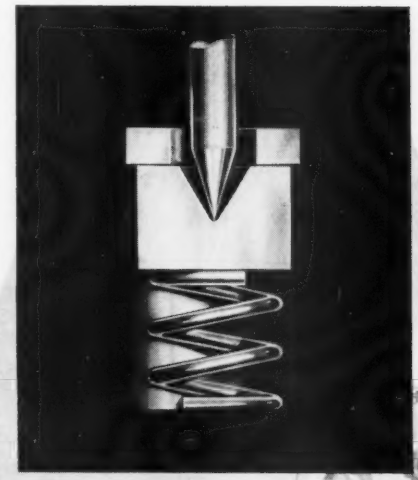
Internal Flow

Shock Compression of a Perfect Gas. Cerda Evans and Foster Evans. *J. Fluid Mech.,* Oct., 1956, pp. 399–408. Theoretical analysis of the compression of a gas by a piston which moves with finite speed for the idealized case of zero heat conduction and viscosity.

Shear Flow Through a Cascade. Appendix—**Effect of Actuator Plane Location.** W. R. Hawthorne, and W. D. Armstrong. *Aero. Quart.,* Nov., 1956, pp. 247–274. Theoretical and experimental investigation of flow through a cascade of untwisted airfoils placed in a wind tunnel of rectangular section in which the approach velocity is varied artificially in the spanwise direction only.

SHOCK ABSORBER WEIGHING ONLY

0.0000028 lb!



Tiny shock-absorbing springs, shown greatly enlarged at the left, provide a *second line of defense* against shock damage in Weston ruggedized panel meters. While the entire instrument movement is cradled on an effective overall shock mount of specially formulated rubber, these tiny shock absorbers, mounted in back of each jewel bearing, provide double protection at the critical points. The spring-backed jewel in ruggedized instruments is another Weston FIRST . . . one which assures continuous, dependable service wherever panel meters are subject to severe impact, vibration or shock.

EXPANDED FACILITIES NOW MAKE WESTON RUGGEDIZED PANEL METERS READILY AVAILABLE FOR MOST NEEDS . . . MANY TYPES AND SIZES FROM STOCK. Consult your nearest Weston representative, or write Weston Electrical Instrument Corp., Newark 12, N. J.

Weston ruggedized instruments are *approved* in all sizes—1½", 2½", 3½", 4½".

WESTON
Ruggedized
PANEL INSTRUMENTS

A GEN. METALS UNIT

KAMAN HOK-1 SHOWS ITS MUSCLE

Undergoing U. S. Army evaluation tests including airlifting externally slung cargo, this Marine Corps HOK-1 demonstrates its ability. Shown here carrying a 2500 lb. jeep, it also takes artillery pieces, gas drums, ammo cases and other bulky materiel in stride.

HOK-1 general utility helicopters are already in service with the U. S. Navy and Marine Corps where they are used extensively for search and rescue missions, medical evacuation, personnel transport and cargo carrying.

The development and production of utility helicopters is but one of many contributions Kaman has made to our National Defense effort. We're proud to be of service.

Kaman builds helicopters YOU FLY LIKE A PLANE

KAMAN

THE KAMAN AIRCRAFT CORPORATION
BLOOMFIELD, CONNECTICUT

Is your n a D on your η ?

For the solution MAIL the coupon

KAMAN

THE KAMAN AIRCRAFT CORPORATION R1
61 Old Windsor Road
Bloomfield, Conn.

Send me solution to your rebus and information on Kaman.
My engineering position is _____

Name _____

Address _____

City _____ State _____

Supersonic Flow Past an Oscillating Cascade with Supersonic Leading-Edge Locus. Frank Lane. *J. Aero. Sci.*, Jan., 1957, pp. 65, 66. Application of the Laplace transform method to study oscillatory supersonic air forces on two-dimensional cascades having nonzero and arbitrary interblade phase-angle lag, provided the locus of blade leading edges is not swept behind the Mach lines.

Untersuchungen über die dreidimensionale Potentialströmung durch axiale Schaufelgitter. Theo Ginsburg. *ETH Inst. für Aerodynamik, Mitteil. No. 22*, 1956. 79 pp. 26 refs. In German. Investigation of the three-dimensional potential flow through axial cascades.

Investigation of Rotating Stall in a Single-Stage Axial Compressor. Appendix—**Pressure Fluctuations in a Downstream Continuum.** S. R. Montgomery and J. J. Braun. *U.S., NACA TN 3823*, Jan., 1957. 28 pp. Tests to determine the number of stall cells and their propagation velocities with and without stator blades. Results are compared with Stenning's theoretical predictions.

Rotating Stall in Single-Stage Axial Flow Compressors. I—Comparison of Three Theories with Three Sets of Experimental Data. II—Extension of Marble's Simple Cascade Theory to Include Effects of Lag. Theodore J. Falk. *Cornell U. Grad. Sch. Aero. Eng. Rep. (AFOSR TN 56-512)[AD 110327]*, Sept., 1956. 67 pp. 17 refs. The three theories include Sears' airfoil and channel predictions and Stenning's and Marble's cascade theories.

A Contribution to the Latticed Wing Solution (The 14th Report of Study of Axial-Flow Turbo-Machine). Shintaro Otsuka. *J. Japan Soc. Aero. Eng.*, Oct., 1956, pp. 1–5. Method of solution is presented for a latticed wing of arbitrary profile.

Sources and Sinks at the Axis of a Rotating Liquid. Robert R. Long. *Quart. J. Mech. & Appl. Math.*, Dec., 1956, pp. 385–393. ONR-sponsored derivation of a solution for the flow of a rotating, frictionless, incompressible fluid due to a strong source or sink at the axis of rotation.

Fluid Flow and Heat Transfer in an Annulus with a Heated Core Tube. Henry Barrow. *IME Proc.*, No. 56, 1955, pp. 1,113–1,123; Communications, p. 1,124; Author's reply, p. 1,124. 17 refs. Theoretical investigation with review of the results and the correlations of a number of previous investigations, and presentation of new friction, velocity, and heat-transfer data from experiments with air flowing turbulently in an annulus of radius ratio 2.248.

Location of Mach Discs and Diamonds in Supersonic Air Jets. Donald E. Wilcox, Alexander Weir, Jr., J. A. Nicholls, and Roger Dunlap. *J. Aero. Sci.*, Feb., 1957, pp. 150–152. OOR-sponsored experimental investigation to determine the effects of the driving-pressure/receiving-pressure ratio, the nozzle-exit Mach Number, and the nozzle divergence angle.

Spreading Characteristics of a Jet Expanding from Choked Nozzles at Mach 1.91. Morris D. Rousso and L. Eugene Baughman. *U.S., NACA TN 3836*, Dec., 1956. 27 pp. Investigation to determine the gross spreading characteristics of jets expanding from axisymmetric convergent and convergent-divergent nozzles in a supersonic stream. Total-temperature surveys are made in a region between the nozzle exit and a station 8 nozzle diameters downstream of the exit for jet-pressure ratios from 2.5 to 16.0.

Penalties due to Jet Misalignment. H. Klein and N. L. Fox. *Douglas Rep. SM-14187*, Nov. 7, 1951. 12 pp. Curves for expected thrust penalties due to misalignment of the exit jet from a jet-propelled aircraft, applicable to turbojet, turboprop, or rocket-driven vehicles.

Stability & Control

Subsonic Wind-Tunnel Investigation of the Effect of Fuselage Afterbody on Directional Stability of Wing-Fuselage Combinations at High Angles of Attack. Edward C. Polhamus and Kenneth P. Spreemann. *U.S., NACA TN 3896*, Dec., 1956. 25 pp.

Theoretical Calculation of the Power Spectra of the Rolling and Yawing Moments on a Wing in Random Turbulence. Appendix—**Evaluation of the Elliptic Integral Weighting Function.** John M. Eggleston and Franklin W. Diederich. *U.S., NACA TN 3864*, Dec., 1956. 56 pp. 17 refs. Calculation of the correlation functions and power spectra due to the three components of continuous random turbulence.

Effects of Vertical Fins Near the Nose of the Fuselage on the Directional and Damping-in-Yaw Stability Derivatives of an Airplane Model Under Steady-State and Oscillatory Conditions. M. J. Queijo and Evalyn G. Wells. *U.S., NACA TN 3814*, Dec., 1956. 54 pp.

Fin-and-Rudder Loads in a Yawing Manoeuvre: Effect of Direct and Power Assisted Rudder Movement. D. R. Puttock. (*Gt. Brit., RAE TN Struc.169*, July, 1955.) *Gt. Brit., ARC CP 301*, 1956. 51 pp. BIS, New York, $1.26. Investigation of the severity of a yawing maneuver as specified for design purposes. It is found that the maneuver does not always represent the most critical case, higher fin and rudder loading being obtainable when the specified frequency of rudder movement is changed.

On a Third Mode of Longitudinal Control-Fixed Oscillation. Bernard Etkin. *J. Aero. Sci.*, Jan., 1957, pp. 71–73. Calculations of a new mode of oscillation, fundamentally different from the short-period and phugoid modes. The mode is best represented by a plot of the loci of the roots of the stability quartic for varying c.g. position. The analysis gives additional information on the dynamic behavior when the c.g. is aft of the neutral point.

Wind-Tunnel Investigation of the Aerodynamic Characteristics in Pitch of Wing-Fuselage Combinations at High Subsonic Speeds; Taper-Ratio Series. Thomas J. King, Jr., and Thomas B. Pasteur, Jr. *U.S., NACA TN 3867*, Dec., 1956. 36 pp. 11 refs.

Wings & Airfoils

An Introduction to Second-Order Wing Theory. D. C. M. Leslie. *J. Aero Sci.*, Feb., 1957, pp. 99–106. Application to wing theory of the Fell-Leslie integral for the iteration equation of inviscid supersonic flow in order to calculate second-order derivatives for wings of finite aspect ratio and to determine the extent to which Busemann's second-order strip theory is in error.

The Investigation of a Straight Wing Having Aerodynamic Sweep. J. Poole and A. V. Stephens. *Australia, ARL Rep. A.89*, Aug., 1954. 28 pp. 11 refs. Tests directed toward producing an isobar pattern in a straight wing that would yield an increase in critical Mach Number (and, hence, in Mach Number at which the drag coefficient starts to increase rapidly and C_m changes) without reducing wing thickness.

The Effect of Dihedral on the Aerodynamic Derivatives with Respect to Sideslip for Airfoils in Supersonic Flow. J. B. L. Powell. *Quart. J. Mech. & Appl. Math.*, Dec., 1956, pp. 425–440. Analysis in supersonic flow of a thin dihedral wing having a small velocity in sideslip. Linearized theory is used to investigate the surface pressure distribution for wings whose plan form is symmetrical about the line of undisturbed flow through the vertex.

The Moving Aerofoil in the Neighbourhood of a Plane Boundary. D. E. Edmunds. *Quart. J. Mech. & Appl. Math.*, Dec., 1956, pp. 400–424. Derivation of a solution by extension of Green's method for a stationary airfoil in a uniform stream near a plane boundary.

On the Theory of Source-Flow from Aerofoils. L. C. Woods. *Quart. J. Mech. & Appl. Math.*, Dec., 1956, pp. 441–456. Development of an exact theoretical treatment of the influence of sources of fluid on and within two-dimensional airfoils. The theory, which takes into account the shape of a duct through which fluid is ejected in the case of a source placed within an airfoil, is given for incompressible flow but is also suitable for extension to deal with linearized, subsonic, compressible flow.

An Investigation at Subsonic Speeds of Several Modifications to the Leading-Edge Region of the NACA 64A010 Airfoil Section Designed to Increase Maximum Lift. Ralph L. Maki and Lynn W. Hunton. *U.S., NACA TN 3871*, Dec., 1956. 50 pp. 18 refs. Results of tests showing that at high speed the maximum-lift increments provided by the leading-edge changes are reduced by the compressibility effects and vanish at about Mach Number 0.65.

On the Minimisation and Numerical Evaluation of Wave Drag. E. Eminton. *Gt. Brit., RAE Rep. Aero.2564*, Nov., 1955. 23 pp. Analysis, using a linearized theory expression for the zero-lift wave drag of a smooth, slender body in terms of its cross-sectional area distribution, to derive the area distribution which minimizes the expression for given length, volume, nose area, base area, and n intermediate areas.

On the Use of Interfering Flow Fields for the Reduction of Drag at Supersonic Speeds. Antonio Ferri and Joseph H. Clarke. (*Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech., PIBAL Rep. 304*, Mar., 1956.) *J. Aero. Sci.*, Jan., 1957, pp. 1–18. 18 refs.

The Warping of Triangular Wings for Minimum Drag at Supersonic Speeds. Doris Cohen. *J. Aero. Sci.*, Jan., 1957,

(*Continued on page 117*)

some time
some how
some place

ready for reality

stafoam

A liquid... poured in place... foams and sets. The miracle material, STAFOAM, results. ... A material with any set of characteristics pre-determined by YOU. It can be formulated to produce a material as hard as steel. It can be formulated to produce a material of sponge-like flexibility. Or it can be formulated to any density between these extremes. STAFOAM can have pre-determined strength, texture, rigidity, porosity, thermal characteristics, insulation characteristics (heat, cold, electrical, shock and sound), and color.

STAFOAM is a polyurethane foam, formed by mixing isocyanates and resinous polymers in liquid form. In some formulas, STAFOAM is thermo-setting; in others, it is thermo-plastic. Consider what just one of STAFOAM'S valuable characteristics ... foamed in place... can mean in savings to your manufacturing process... in engineering, in tooling, in assembly and of course in labor. STAFOAM is a material that could well revolutionize your manufacturing methods... or even your product.

The applications of STAFOAM are limited only by your imagination.

STAFOAM is in your future.

☐ *Send me Brochure on Rigid Stafoam.*

☐ *Send me Brochure on Flexible Stafoam.*

... In the infinity of the future that begins in the next instant, people like yourselves ... scientists, engineers and intelligent businessmen ... will be dreaming of things for a better world. And these dreams ... the formulas and the blueprints ... will be rushed into realities because other men who believe in the future are now working to provide you with the methods and materials that will give wings to your imagination.

Your dreams will influence not only your own lives but the lives of millions of people. You will make food tastier and fresher. You will make sleep and relaxation more comfortable. You will control temperature to an even greater degree ... to suit every human and technical need. You will make travel faster and safer. You will make communications more diversified, more dependable and more complete. You will manufacture the complicated devices of the atomic age by increasingly simplified procedures. In short, you will make life more enjoyable in many ways.

... And there is a NEW MIRACLE MATERIAL which will help provide an early fulfillment of these "dreams." The scientists who are now developing the wide range of properties inherent in this material cannot envision all of its applications. But you ... the scientist, the engineer or the businessman with imagination ... can work with the Research and Development staff of American Latex Products Corporation toward applications only *you* can dream of ...

The future is now ... this NEW MIRACLE MATERIAL IS HERE!

AMERICAN LATEX

PRODUCTS CORPORATION

3341 West El Segundo Blvd., Hawthorne, Calif.

Please complete space below, and send us this page.

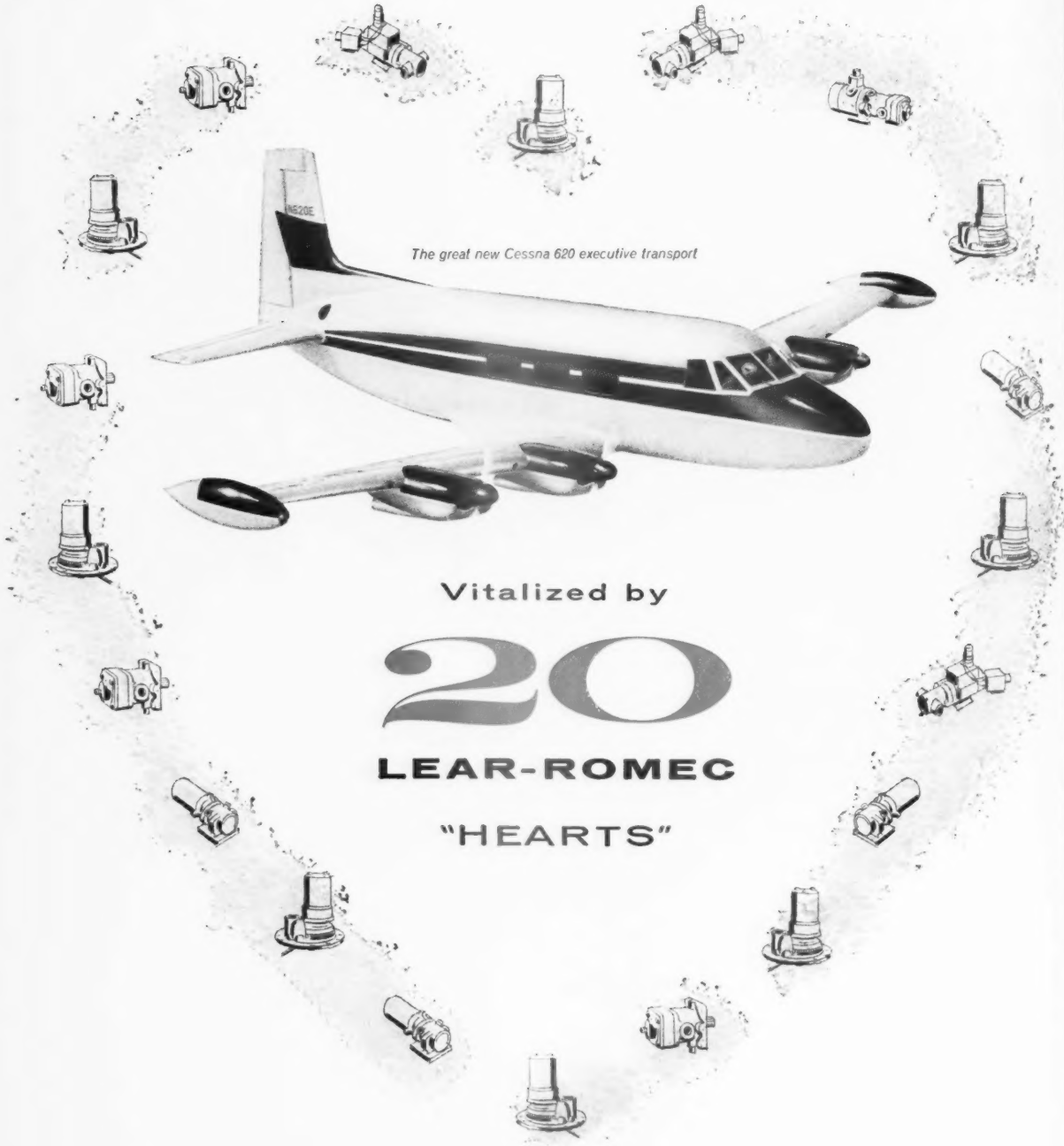
Name.....

Title or Code No......

Company.....

Address.....

.....



The great new Cessna 620 executive transport

Vitalized by

20

LEAR-ROMEC

"HEARTS"

The 620's fuel pumps, fuel booster pumps, fuel transfer pumps, gas turbine A.P.U. fuel pump, alcohol pumps, and unfeathering pumps – twenty, altogether – are all products of Lear Incorporated, Lear-Romec Division, Elyria, Ohio.

LEAR-ROMEC

makes the second best pumps in the world.

RO-21

INTERNATIONAL AERONAUTICAL ABSTRACTS

A Review of Worldwide Scientific and Technical Literature

Selected and prepared by the IAS Staff from currently released material received in the IAS Library. This research was supported in whole or in part by the United States Air Force under Contract No. AF 49(638) - 185 monitored by the AF Office of Scientific Research of the Air Research and Development Command. The literature abstracted in this section is available through the lending or photocopying services of the IAS Library, New York.

PUBLISHED MONTHLY BY THE AERONAUTICAL ENGINEERING REVIEW

Official Publication of the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

Volume 2, Number 3 March, 1957

ACOUSTICS, SOUND, & NOISE

ON THE CONTRIBUTION OF TURBULENT BOUNDARY LAYERS TO THE NOISE INSIDE A FUSELAGE. Appendix I - THE RANDOM RADIATION OF A PLANE SURFACE. Appendix II - THE SIMPLIFICATION OF THE PLATE RESPONSE INTEGRAL. Appendix III - THE EVALUATION OF THE INTEGRAL SCALE. G. M. Corcos and H. W. Liepmann. US, NACA TM 1420, Dec., 1956. 43 pp. Analysis of random noise transmission through a fuselage. The concept of attenuation is abandoned, and instead the problem is formulated as a sequence of two linear couplings: the turbulent-boundary-layer fluctuations excite the fuselage skin in lateral vibrations and the skin vibrations induce sound inside the fuselage. The techniques used are those required to determine the response of linear systems to random forcing functions of several variables. The results show that sound pressure intensity is proportional to the square of the free-stream density, the square of cabin air density, and inversely proportional to the damping constant and the second power of the plate density.

ON THE NOISE FROM SUPERSONIC JETS. E. J. Richards. (2nd Internatl. Cong. on Acoustics, Cambridge, July, 1956.) J. RAeS, Jan., 1957, pp. 43-45. Theoretical and experimental investigation which indicates that the noise emitted from the interaction between the turbulence in a jet and the standing shock pattern depends primarily on the strength of the turbulence and less on the shock conditions. It is concluded that an appreciable noise reduction can be obtained by using a convergent-divergent nozzle but that this reduction is confined to a small pressure ratio range around the correct ratio for that nozzle.

AERODYNAMICS

Aerothermodynamics

NEW METHODS IN HEAT FLOW ANALYSIS WITH APPLICATION TO FLIGHT STRUCTURES. M. A. Biot. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 661. 30 pp. Members, $0.65; nonmembers, $1.00. (Also in Cornell Aero. Lab. Rep. SA-987-S-3, May, 1956.) Presentation of techniques which are in part a direct application of some general variational principles (developed earlier for linear thermodynamics) extended to lead to drastic simplifications in calculation and, in the case of purely thermal problems, to include surface and boundary-layer heat transfer, nonlinear systems with temperature-dependent parameters, and radiation. Introduction of the concepts of thermal potential, dissipation function, and generalized thermal force results in ordinary Lagrangian-type differential equations for the thermal flow field. The concepts of penetration depth and transit time are also introduced and discussed in connection with one-dimensional flow. The general method is applied to the heating of a slab with temperature-dependent heat capacity and an illustrative heat-flow analysis is carried out for a supersonic wing structure.

Boundary Layer

A THEORETICAL AND EXPERIMENTAL STUDY OF THE BOUNDARY LAYER FLOW ON A 45° SWEPT BACK WING. Appendix I - PILOT'S HANDLING TECHNIQUES, B. F. Russell. Appendix II - CALCULATION OF THE DISTRIBUTIONS OF VELOCITY AND PRESSURE OVER THE WING AT ZERO INCIDENCE. Appendix III - THE CALCULATION OF THE STEADY STATE THREE DIMENSIONAL BOUNDARY LAYER FOR THE SHEARED WING OF INFINITE SPAN BY THE METHOD OF SERIES. Appendix IV - THE THREE DIMENSIONAL BOUNDARY LAYER FOR THE POTENTIAL FLOW. F. M. Burrows. Coll. of Aeronautics, Cranfield, Rep. 109, Oct., 1956. 102 pp. 36 refs. Investigation giving particular attention to the onset of boundary-layer instability and its association with critical values of secondary-flow Reynolds Numbers as defined by Owen and Randall. Experimentation involves in-flight tests on a large untapered, untwisted 45° sweptback half wing mounted as a dorsal fin on the mid-upper fuselage of an Avro Lancaster (P. A.

474) to achieve a Reynolds Number range of 0.88 x 10^6 to 1.92 x 10^6 per ft. Curves are presented giving details of the measured distributions of static pressure, chordwise loadings, and the boundary-layer flow for wing geometric incidences in the range 0^o to 10^o, for upper and lower surfaces, and for the test Reynolds Numbers.

ON POSSIBLE SIMILARITY SOLUTIONS FOR THREE-DIMENSIONAL INCOMPRESSIBLE LAMINAR BOUNDARY LAYERS. III - SIMILARITY WITH RESPECT TO STATIONARY POLAR COORDINATES FOR SMALL ANGLE VARIATION. H. Z. Herzig and A. G. Hansen. US, NACA TN 3890, Jan., 1957. 36 pp. 16 refs. Derivation of approximate solutions, summarized in a table, which describe mainstream flows including accelerating or decelerating flows as well as stagnation-point, spiral, or circular flows. Theoretical predictions are compared with experimental data on limiting overturning at the wall and good agreement is achieved for the first 10^o of turning of circular mainstream flow.

THE PROPERTIES OF EQUILIBRIUM BOUNDARY LAYERS. A. A. Townsend. J. Fluid Mech., Dec., 1956, pp. 561-573. 10 refs. Comparison of recent investigations on equilibrium turbulent boundary layers in adverse pressure gradients with the theoretical predictions based on current generalizations about turbulent shear flow. Using only assumptions of similarity, it is possible to show that an equilibrium layer can exist only if the free-stream velocity varies as a power of distance downstream with an exponent greater than -1/3 and if the velocity defect from the free stream is small. Assuming further that the effective eddy viscosity is independent of distance from the wall over the outer part of the layer, most of the properties of equilibrium layers can be computed from the known behavior of layers in zero pressure gradient.

BOUNDARY-LAYER TRANSITION BY ROUGHNESS ELEMENT. Itiro Tani and Hiroshi Sato. J. Phys. Soc. Japan, Dec., 1956, pp. 1, 284-1, 291. 17 refs. Two-dimensional low-turbulence wind-tunnel investigation to obtain measurements on the boundary layer along a flat plate to which a fine rod is attached as a two-dimensional roughness element. Hot-wire equipment is used to investigate the resulting transition from laminar to turbulent flow. A marked contrast is shown to exist between the transition when the ratio of roughness-element height to boundary-layer thickness at the element is small, and the transition when this ratio is large.

PROGRESS IN LOW-DRAG BOUNDARY-LAYER CONTROL. Edgar Schmued. (IAS Sect. Meeting, Wash., Jan. 8, 1957, Paper.) Aero. Eng. Rev., Mar., 1957, pp. 34 - 36. Review of experiments in the application of boundary-layer control for drag reduction, and discussion of the resulting gain in performance for long-range aircraft. Results indicate that boundary-layer control will be beneficial for long-range cruising at subsonic as well as subsonic speeds and that the effect should be a large reduction in weapon-system costs.

Control Surfaces

A METHOD FOR PREDICTING LIFT INCREMENTS DUE TO FLAP DEFLECTION AT LOW ANGLES OF ATTACK IN INCOMPRESSIBLE FLOW. Appendix - SIMPLIFIED METHOD OF ESTIMATING C_L THROUGHOUT THE SUBSONIC SPEED RANGE. J. G. Lowry and E. C. Polhamus. US, NACA TN 3911, Jan., 1957. 29 pp. 18 refs. Application of incremental section-lift data to the estimation of the effectiveness of high-lift flaps. The technique can be used on swept wings of any aspect ratio or taper ratio.

NON-LINEAR OSCILLATIONS OF AN ALL-MOVABLE STABILIZER AT SUPERSONIC SPEEDS. Appendix I - EQUATIONS OF MOTION. Appendix II - FACTORIZATION OF THE PERFORMANCE FUNCTION. A. S. Richardson, Jr. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 685. 27 pp. Members, $0.65; nonmembers, $1.00. Theoretical investigation of an all-movable stabilizer considered together with the hydraulic servomechanism as a three-degrees-of-freedom dynamic system. The system is capable of five types of unstable behavior: static divergence, classical flutter, two types of servo flutter, and closed-loop instability. Linear analysis is followed by nonlinear analysis, with both treatments emphasizing closed-loop behavior near the classical flutter instability.

THE JET-AUGMENTED FLAP. J. G. Lowry, J. M. Riebe, and J. P. Campbell. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 715. 57 pp. 23 refs. Members, $0.35; nonmembers, $0.75. Discussion of the jet-augmentation principle with emphasis on the integration of the propulsion and lifting systems. Some of the fundamental aerodynamic characteristics of jet-augmented flaps are given for finite aspect-ratio wings, and some guides are provided to follow in the prediction of the aerodynamic characteristics. In addition, the effect of proximity of the ground and the downwash field behind the wing is briefly discussed. It is shown that thrust recoveries larger than the jet reaction in the thrust direction can be expected for the jet-augmented flap.

AERODYNAMIC INTERFERENCE OF SLENDER WING-TAIL COMBINATIONS. A. H. Sacks. US, NACA TN 3725, Jan., 1957. 81 pp. 18 refs. Calculation of the variations of total forces and moments with angles of attack and sideslip for a number of slender plane and cruciform wing-tail combinations under the assumption that the vortex sheet is fully rolled up ahead of the tail. Significant nonlinearities are found and discussed in connection with static stability. Includes water-tank photographs of the wake in the presence of the tail.

Fluid Mechanics & Aerodynamic Theory

RECENT DEVELOPMENTS IN THE METHOD OF THE RHEOELECTRIC ANALOGY APPLIED TO AERODYNAMICS. L. C. Malavard. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 699. 19 pp. 11 refs. Members, $0.50; nonmembers, $0.85. Discussion of the use of rheo-

electric analogies as a method for the direct plotting of isogradient and iso-argument lines of a plane harmonic field; for interpreting a linearized theory of a wing jet flap and the results obtained on an airfoil section; for studying jet-flap action on a lifting surface; and for calculating the aerodynamic characteristics of the annular wing.

SÉPARATION DE L'ÉCOULEMENT LAMINAIRE TRIDIMENSIONNEL. Robert Legendre. La Recherche Aéronautique, Nov.-Dec., 1956, pp. 3-8. In French. Analytical study of the flow field around a three-dimensional obstacle without singularities. It is shown how the concepts of uniformity and null divergence of the vector flux can be used to describe the type of singularities arising in the flow and on the surface of the obstacle.

BASE PRESSURES IN SUPERSONIC FLOW. G. E. Gadd, D. W. Holder, and J. D. Regan. Gt. Brit., ARC CP 271, 1956. 26 pp. 11 refs. BIS, New York, $0.72. Direct-discharge-tunnel investigation of model shapes primarily including (a) two-dimensional wedges with base/chord ratios of 1/4 and 1/8, (b) cones of 10° semiangle, and (c) cone-cylinder bodies of revolution with 30° semiangle heads and lengths of 3 and 7 diameters. Tests include measurements of the base pressure behind a shallow two-dimensional step at a free-stream Mach Number of 3 and behind a wedge on a plate, forming a "half model" of the larger wedge (a), at M=3 and M=4.

INVESTIGATION OF VARIATION IN BASE PRESSURE OVER THE REYNOLDS NUMBER RANGE IN WHICH WAKE TRANSITION OCCURS FOR NON-LIFTING BODIES OF REVOLUTION AT MACH NUMBERS FROM 1.62 TO 2.62. Vernon Van Hise. US, NACA TN 3942, Jan., 1957. 41 pp. Results of tests compared with previous base-pressure data and also with the qualitative theoretical predictions of Crocco and Lees. Throughout the realm of wake transition the base pressure is found to vary with both Reynolds Number and Mach Number in the same qualitative manner as given by the Crocco and Lees theory.

INVISCID HYPERSONIC FLOW PAST BLUNT BODIES. S. H. Maslen and W. E. Moeckel. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 665. 19 pp. Members, $0.50; nonmembers, $0.85. Two methods for calculating the flow field, including real gas effects, between a blunt body and the shock associated with it, for the case of hypersonic flow. One method involves tracing successive steamtubes around the body and leads to iterations on the initially assumed position of the shock; the second is an integral method closely analogous to the von Kármán-Pohlhausen procedure for boundary layers.

FLOW IN A VISCOUS VORTEX. C. D. Pengelley. J. Appl. Phys., Jan., 1957, pp. 86-92. OSR-supported derivation of equations for velocity, temperature, and pressure distribution in a two-dimensional compressible viscous vortex with a steady-state component of radial flow. Radial velocity is assumed small compared with the tangential, and heat transfer is neglected. A reference radius is defined where viscous stress is zero. From this, nondimensional forms are set up and generalized charts prepared for ready visualization and numerical application. Because of the classical concept of viscosity as used in the Navier-Stokes equation, results are strictly applicable to laminar flow only.

NOTE ON THE FLOW JUST BEHIND THREE-DIMENSIONAL SHOCK. Shigeki Morioka. J. Japan Soc. Aero. Eng., Dec., 1956, pp. 9-14. Derivation of concise expressions for the flow quantities just behind a steady three-dimensional shock with respect to the space coordinates. Analysis is based on Thomas' method and assumes a regular shock surface. The expressions, which are applied to the special cases of flow just behind a two-dimensional and an axially symmetrical shock, are simplified when the lengths of the lines of curvature are used as parameters. A consistency relation is derived for axially symmetrical shock, and it is shown that the distribution of singular shock directions is the same for axially symmetrical as for two-dimensional shock.

ON THE "TRIPLE POINT" IN SHOCK-DIFFRACTION PROBLEMS. Tien-Fun Sun. Cornell U. Grad. Sch. Aero. Eng. Rep. (AFOSR TN 56-583) [AD 115077], Sept., 1956. 122 pp. 16 refs. Study of a straight shock wave diffracted by an infinitely long wedge and interacting with the incident or the reflected shock. An analysis is made to determine the flow inside the diffracted wave, the position and the strength of the diffracted wave, and, in particular, how it attenuates the incident or the reflected shock at the points (triple points) where it intersects them. From the tangential and normal shock conditions a set of simultaneous nonlinear integro-differential equations, governing the transition function and shock position, is obtained. A numerical solution based on polynomial approximation to the unknowns is carried out.

EXPERIMENTAL STUDIES ON THE SPECTRUM OF ISOTROPIC TURBULENCE BEHIND TWO GRIDS. Hiroshi Tsuji. J. Phys. Soc. Japan, Oct., 1956, pp. 1,096-1,104. 15 refs. Investigation using hot-wire measurements to determine the energy spectrum and decay of spectral components of turbulence behind two grids in order to study the characteristics of isotropic turbulence produced under various initial conditions and at high Reynolds Numbers. Results indicate that the similarity of the energy spectrum holds only for the high wave-number range, while the low wave-number characteristics of turbulence depend on the initial conditions and exhibit no similarity. The similarity of the vorticity spectrum is observed over almost the entire wave-number region for the turbulence either behind a single or a double grid unless high wave-number disturbances are superposed. Therefore Lin's decay law is expected to be valid for the turbulence either behind a single grid or with superposed disturbances of low wave numbers.

IRROTATIONAL MOTION ASSOCIATED WITH FREE TURBULENT FLOWS. R. W. Stewart. J. Fluid Mech., Dec., 1956, pp. 593-606. Analysis

of irrotational motions induced by, but outside of, the self-preserving turbulent wake and jet. Phillips' results are extended to some situations in which the statistical properties of the velocity component u_2 are not independent of both cartesian coordinates x_1 and x_3. x_1 is taken as the principal direction of flow and x_3 is considered parallel to any direction of symmetry. It is found that there is a mean flow towards the center of the jet, although there is no such flow in the case of the wake. Phillips' results on the nature of fluctuating irrotational flows are found to be largely unaffected by the introduction of simple inhomogeneities into the boundary conditions, but another mode of fluctuation with movement along the lines of mean flow is also shown to be likely. It is pointed out that it is possible for the vorticity-free fluid between bulges of turbulent fluid to partake of the mean velocity of the turbulent fluid.

Internal Flow

EFFECTS OF COMPRESSIBILITY AT LOW REYNOLDS NUMBERS. G. I. Taylor. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 725. 10 pp. Members, $0.35; nonmembers, $0.75. Theoretical investigation of the effects of two possible errors in Reiner's experiment (for the flow between the rotor and the stator) which apparently established a non-Newtonian character of air flow - interpreted as a refutation of the Navier-Stokes equation. Considered are the effect of a slight error in the perpendicularity of the plane of either (or both) the stator or rotor to the axis of rotation and the effect of vibration of the rotor in the direction of the axis. Two experiments are undertaken, and while their results do not disallow the existence of the non-Newtonian character of air flow assumed by Reiner, they do show that his data are to be expected on the basis of the Navier-Stokes equation.

EXPERIMENTAL INVESTIGATION OF THE ROTATING STALL IN A SINGLE STAGE AXIAL COMPRESSOR. Appendix - PRINCIPLES OF THEORETICAL COMPUTATION OF ROTATING STALL ABSOLUTE ROTATIVE SPEED. Jacques Valensi. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 700. 15 pp. 16 refs. Members, $0.50; nonmembers, $0.85. ARDC-sponsored research carried out by means of (a) dynamic-stagnation- and static-pressure measurements and (b) smoke surveys. It is shown that the two techniques achieve mutually compatible results and that the smoke surveys offer considerable assistance as well in explaining the rotating-stall mechanism.

ROTATING STALL IN AXIAL FLOW COMPRESSORS. Appendix I - CORRESPONDANCES BETWEEN TWO HARMONIC FLOW FIELDS RELATED BY MEANS OF A LINEAR COMBINATION ALONG THEIR COMMON BOUNDARY. Appendix II - THE HILBERT PROBLEM. Jean Fabri and Raymond Siestrunck. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 692. 15 pp. 12 refs. Members, $0.50; nonmembers, $0.85. Derivation of an aerodynamic theory which predicts the relation between the rate of stall propagation and the static pressure behind the rotor; the extent of the stall zones as a function of the flow coefficient; the upstream decay of the disturbance; and the downstream mixing of the flow. The theory is based on a physical scheme which assumes saturation of the R-angle of attack (angles of attack relative to the rotor) and no through flow in the stalled blade channels.

FLUTTER VELOCITY AND AMPLITUDE PREDICTIONS ON ISOLATED BLADES IN STALLED FLOW BY SINGLE-DEGREE-OF-FREEDOM ANALYSIS. R. J. Vaccaro. NYU Coll. Eng. Res. Div. Rep. 354-2 (AFOSR TN 56-592) [AD 115019], Jan., 1957. 108 pp. Analysis of stall flutter in which the equations of motion are employed to compute oscillatory air forces in the stall region from flutter tests on isolated blades restricted to oscillate in torsion. The air forces are employed to predict flutter speeds and frequencies for two-degree-of-freedom and cantilever systems, and take the form of a real and an imaginary part of the moment coefficient versus k for given values of initial angle of attack, elastic axis location, and airfoil shape. It is found that these check quite accurately with values obtained from tests on the systems themselves. Finally, by applying the methods of nonlinear mechanics, it is found that an estimate of the torsional amplitude at the tip can be obtained for a cantilever blade. Also includes a description of the flutter cascade tunnel.

INVESTIGATION OF SUPERSONIC DIFFUSER INSTABILITY. A. C. Brown. USCEC Final Rep. 41-101 (AFOSR TR 57-1) [AD 115038], Nov. 30, 1956. 78 pp. Experimental investigation conducted over a complete mass flow range with a selection of models covering a variety of geometrical features in order to correlate and analyze the different types of oscillation which may be observed. The four models used include a pitot intake, an axially symmetric diffuser with a center body, a ramp, and a scoop intake. All of them have a common plenum chamber and sonic throttle and are tested at a Mach Number of 2.54.

UBER DAS VERHALTEN KOMPRESSIBLER MEDIEN BEI DER STRÖMUNG DURCH GERADE SCHAUFELGITTER. M. Ludewig. Forschung Gebiete Ing., Ausg. A, No. 6, 1956, pp. 181-191. 12 refs. In German. Investigation of the flow of compressible media through straight cascades. The laws of momentum, energy, continuity, and gas are used to derive a basic equation for the ratio of inflow to outflow velocity with respect to frictionless flow through cascades consisting of thin and straight blades. Includes extension to flow with frictional losses and calculation of the adiabatic compression efficiency of the shock waves in supersonic flow.

ON LAMINAR FLOW THROUGH A CHANNEL OR TUBE WITH INJECTION; APPLICATION OF METHOD OF AVERAGES. Morris Morduchow. Quart. Appl. Math., Jan., 1957, pp. 361-368. OSR-OOR-ONR-sponsored derivation of a simple approximate closed-form solution - valid for the entire range of normal fluid-injection velocities from zero

to indefinitely large - for the flow through a channel and through a circular tube with porous walls. The method of averages is used in conjuction with auxiliary boundary conditions derived from the governing ordinary differential equation, and the solutions thus obtained are shown to reduce exactly to the small-perturbation solutions for small values of the injection (or suction) velocity at the wall and approximately to the exact asymptotic solutions for infinite values of the injection velocity.

A NOTE ON THE APPROXIMATION ABOUT AXIALLY SYMMETRIC SUPERSONIC FLOW. Takashi Tani. J. Japan Soc. Aero. Eng., Dec., 1956, pp. 1-3. In Japanese. Examination of the disturbance of axial velocity component in the simplified equation of axially symmetric moderate supersonic flow. The modified stream-function equation is transformed to the usual linearized equation, and analysis treats a jet and conical flows as special cases.

THE WALL JET. M. B. Glauert. J. Fluid Mech., Dec., 1956, pp. 625-643. Analysis of flow due to a jet spreading out over a plane surface, either radially or in two dimensions. Solutions of the boundary layer equations in which the form of the velocity distribution across the jet does not vary along its length are sought. For laminar flow, such a similarity solution is obtained explicitly. For turbulent flow, an eddy viscosity is introduced and it is eventually shown that complete similarity is not obtainable, but predictions can be made about the nature of the velocity distribution and the rate of growth of the wall jet.

Stability & Control

A THEORETICAL AND EXPERIMENTAL STUDY OF AIRPLANE DYNAMICS IN LARGE-DISTURBANCE MANEUVERS. D. W. Rhoads and J. M. Schuler. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 717. 31 pp. 15 refs. Members, $0.65; nonmembers, $1.00. Analysis of the nonlinear aspects of airplane dynamics and control with emphasis on the rolling pullout, a critical maneuver for vertical tail loads. Equations of motion are developed, and solutions are compared with responses obtained from flight tests. The equations are then applied to critical present-day aircraft, and a general study of large-disturbance motion is made, including the variation of pertinent parameters. The results are based on five degrees of freedom and show that the inertial and aerodynamic nonlinearities introduce destabilizing tendencies not predicted by linear theory. Although complex equations are required to predict motions accurately, simple mathematical techniques can be used to describe the characteristics of the motion.

VORTEX INTERFERENCE EFFECTS ON THE AERODYNAMICS OF SLENDER AIRPLANES AND MISSILES. A. H. Sacks. IAS 25th Annual Meeting, New York, Jan. 28-31, 1956, Preprint 688. 19 pp. 18 refs. Members, $0.50; nonmembers, $0.85. Description of a method for calculating the vortex strengths and positions at the tail and, particularly, the corresponding forces and moments due to vortex interference. Results for longitudinal stability indicate that either a low horizontal tail or a very high T tail is often effective in eliminating adverse vortex-interference effects; a canard arrangement also seems to have possibilities for giving reasonable linear characteristics; and, if the span of the tail is restricted by other considerations, a horizontal tail of a span slightly less than that of the vortex should give smoother characteristics than one whose span is greater than that of the vortex. A ventral fin appears to be beneficial for directional stability. The most efficient practice for achieving all-over stability, however, may be to fill in the gaps between the wing and tail surfaces to eliminate wing-tail interference.

Wings & Airfoils

GENERALIZED AEROFOIL THEORY. L. C. Woods. Proc. Royal Soc. (London), Ser. A, Jan. 8, 1957, pp. 358-388. 20 refs. Development of a theory to calculate the flow of an inviscid compressible gas at subsonic speeds past a porous airfoil with a given pressure on the inside of the porous surface. Generalized forms of Blasius' formulas for the lift and moment in incompressible flow are obtained for tangent gas and applied to the porous airfoil problem. The method is based on an integral equation directly applicable to the given circulation and profile shape. The theory is shown to yield as special cases (a) the flow about a given airfoil, (b) the design of an airfoil for a given pressure distribution, (c) the flow about a given airfoil with point sources or sinks on the surface, (d) flow about a thin-airfoil with a limited region of flow separation, and (e) the flow about bluff bodies to which finite bubbles or cavities adhere.

METHODS OF REDUCING THE TRANSONIC DRAG OF SWEPT-BACK WINGS AT ZERO LIFT. D. Küchemann. J. RAeS, Jan., 1957, pp. 37-42. 12 refs. Review of the theory and methods for reducing normal-pressure drag of wings and wing-body combinations. The discussion indicates that the greatest improvements in zero-lift drag can be achieved in transonic flow, with the design Mach Number near the critical Mach Number of the sheared wing. It also appears that it will be more difficult to reduce substantially the normal-pressure drag once a truly supersonic type of flow has been established, because the flow fields of the body and wing cannot be properly matched.

SIDEWASH IN THE VICINITY OF LIFTING SWEPT WINGS AT SUPERSONIC SPEEDS. Appendix A - DETERMINATION OF SIDEWASH EXPRESSIONS. Appendix B - EVALUATION OF IMAGINARY PART OF AN INCOMPLETE ELLIPTIC INTEGRAL OF THE SECOND KIND WITH A COMPLEX ARGUMENT. P. J. Bobbitt and P. J. Maxie, Jr. US, NACA TN 3938, Feb., 1957. 49 pp. Equations and charts suitable for determining sidewash both in the vicinity of semiinfinite triangular wings at small angles of attack and for the conical part of the flow exterior to wings having finite spans and chords. Consideration is given to the subsonic wing as well as to the supersonic-wing leading-edge conditions in

order to provide a means for determining sidewash for all supersonic Mach Numbers and leading-edge sweep angles for sweptback wings.

COMPARISON OF CALCULATED AND EXPERIMENTAL LOAD DISTRIBUTIONS OF THIN WINGS AT HIGH SUBSONIC AND SONIC SPEEDS. Appendix A - DERIVATION OF DOWNWASH FACTOR E. Appendix B - APPROXIMATE INTEGRATION IN THE CHORDWISE DIRECTION AND FORMATION OF THE DOWNWASH EQUATIONS. Appendix C - AERODYNAMIC CHARACTERISTICS. J. L. Crigler. US, NACA TN 3941, Jan., 1957. 46 pp. Method is presented for determining the span load distribution of a wing in combination with a body. Comparison with experimental results indicates that both magnitude and distribution are in good agreement up to the 0.95 Mach Number.

EFFECTS OF LEADING-EDGE SEPARATIONS ON THIN WINGS IN TWO-DIMENSIONAL INCOMPRESSIBLE FLOW. L. F. Crabtree. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 659. 14 pp. 34 refs. Members, $0.50; nonmembers, $0.85. Summary of recent theoretical work carried out mainly at the RAE on the flow over an airfoil with a separation bubble near the leading edge. A physical picture of such bubble flows is built up and a solution is sought by dividing the problem into three parts concerning the viscous flow inside the bubble, the turbulent mixing region of reattachment, and the inviscid external flow. Attention is also given to the problem of transition in the separated shear layer in order to arrive at a hypothesis regarding the leading-edge stall or abrupt change from a short to a long bubble, and the problem of predicting maximum lift is discussed in an effort to provide a detailed explanation of the scale effect on the stalling characteristics of thin and moderately thin airfoils.

TURBULENCE IN THE WAKE OF A THIN AIRFOIL AT LOW SPEEDS. Appendix A, B - APPLICATION OF STABILITY THEORY TO THE PREDICTION OF WAKE FREQUENCIES. G. S. Campbell. US, NACA TM 1427, Jan., 1957. 63 pp. 24 refs. Total-head measurements and measurements of turbulent intensity and power spectra of the velocity fluctuations at a Reynolds Number of 1.6×10^5 for several angles of attack in order to provide data for analyzing the tail-buffeting problem in aircraft design. Mean-square downwash is shown to have nearly the same dependence on vertical position in the wake as that evidenced by total-head loss. Power-spectra measurements indicate a decrease in frequency with increasing wing angle of attack, the average frequency in the wake being proportional to the ratio of mean wake velocity to wake width.

ON THE EVALUATION OF GENERALIZED AERODYNAMIC FORCES FOR TRIANGULAR WINGS WITH SUPERSONIC LEADING EDGES. Y. L. Luke, P. C. Constant, and B. E. Ruhlman. Midwest Res. Inst., WADC TR 56-525, Oct. 1, 1956. 38 pp. Description of a numerical calculation procedure which is more easily applied than the Walsh-Zartarian-Voss method. The present approach results from close examination of the question of strip theory vs. exact theory. Includes numerical examples, tables of the generalized aerodynamic force components, and discussion of the two groups of parameters which must be selected for evaluation of these forces.

A THEORETICAL INVESTIGATION OF THE DRAG OF GENERALIZED AIRCRAFT CONFIGURATIONS IN SUPERSONIC FLOW. E. W. Graham, P. A. Lagerstrom, R. M. Licher, and B. J. Beane. US, NACA TM 1421, Jan., 1957. 108 pp. 23 refs. Consideration of methods for determining the pressure drag for unconventional wing-body combinations which may offer advantages in drag reduction and study of a few of the drag-reduction possibilities in highly idealized aircraft. Such idealized aircraft are defined by distributions of lift and volume in three-dimensional space. Hayes' method of drag evaluation, which is derived in detail starting with the general momentum theory, is the fundamental tool used. The basic singularities such as sources, dipoles, lifting elements, and volume elements are discussed, and some of the useful interrelations between these elements are presented.

FAVORABLE INTERFERENCE IN LIFTING SYSTEMS IN SUPERSONIC FLOW. Antonio Ferri, J. H. Clarke, and Lu Ting. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 664. 23 pp. 18 refs. Members, $0.65; nonmembers, $1.00. Application of certain simple integral relations to the qualitative assessment and calculation of the favorable interference effects arising in various spatial arrangements of wings and bodies in a supersonic stream. The arrangements include slender bodies in proximity to wings, biplanes with underslung pylons or other vertical surfaces, and wing-fuselage combinations. Vertically antisymmetric modifications of the fuselage shape in the neighborhood of the wing are suggested to reduce the drag due to lift of midwing-body systems.

AEROELASTICITY

AN INVESTIGATION OF THE FLUTTER OF RECTANGULAR WINGS WITH TIP MASSES. III - WING STIFFNESS AND RESONANCE TESTING. Appendix I - EFFECT OF ROLL FLEXIBILITY ON NATURAL FREQUENCIES. Appendix II - EFFECT OF VERTICAL TRANSLATION FLEXIBILITY OF ROOT CONSTRAINT ON FUNDAMENTAL NATURAL FREQUENCY. Appendix III - EFFECT OF VIBRATOR ON NATURAL FREQUENCIES AND MODES OF VIBRATION. Appendix IV - ESTIMATION OF EFFECTIVE DYNAMIC STIFFNESS. C. M. Bailey and R. W. Traill-Nash. Appendix V - HSAD STATIC AND DYNAMIC TESTING. H. W. Evans and R. J. Rockliff. Australia, Rep. WRE/HSA7 ARL/SM 238, Feb., 1956. 64 pp. Results of tests on twelve pairs of rectangular unswept wings. The effect of flexibility on the wing mounting rig for measured natural frequencies is examined, and some conclusions are drawn in relation to optimum vibrator arrangement. It is found that discrepancies occur between measured natural frequencies and corresponding frequencies calculated on the basis of statically measured stiffness. This is attributed to variation

of elastic moduli of balsa wood with rate of loading, and a method is given for correction of the stiffness estimates to make them consistent with measured natural frequencies. Wing properties are found to vary with the change in ambient conditions of temperature and relative humidity.

FLUTTER OF RECTANGULAR SIMPLY SUPPORTED PANELS AT HIGH SUPERSONIC SPEEDS. J. M. Hedgepeth. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 713. 44 pp. 26 refs. Members, $0.35; nonmembers, $0.75. Theoretical analysis of panel flutter under the assumption that the "static" approximation to the aerodynamic flutter forces yields flutter boundaries with satisfactory accuracy for Mach Numbers greater than two. Two panel flutter analyses are performed using this static approximation in conjuction with thin-plate theory: one employs aerodynamic strip theory; the other, aerodynamic surface theory. The influence of Mach Number, dynamic pressure, panel aspect ratio, and midplane stress on the panel thickness required to prevent flutter is determined for extensive ranges of these parameters.

FREE LATERAL VIBRATION OF BEAMS OF VARIABLE CROSS SECTION. E. W. Suppiger and N. J. Taleb. ZAMP, Nov. 25, 1956, pp. 501-520. 14 refs. Derivation of solutions for beams with different end conditions and for two specific examples. Analysis is carried out by means of the differential equation of motion for beams with cross-sectional areas and moments of inertia that vary in an exponential manner. For simplicity, calculations are limited to the first and second modes.

THE EQUATIONS OF MOTION FOR CURVED AND TWISTED ELASTIC BARS DEDUCED BY THE USE OF THE "METHOD OF INTERNAL CONSTRAINTS". E. Volterra. Ing.-Arch., No. 6, 1956, pp. 392-400. Extension of previous work on curved bars to determine equations of motion for curved and twisted bars, taking into account the effects of shear and of rotatory inertia. From the fundamental Riemannian metric tensor, the covariant and controvariant components of strain are derived, and from these the expressions for the kinetic and potential energies of the bar are derived in terms of nine unknown controvariant components of the three vectors $\vec{v}$, $\vec{\lambda}$, and $\vec{\mu}$. The application of Hamilton's principle furnishes the nine differential equations of motion and the boundary conditions which univocally determine the nine unknown functions in the case of free vibrations.

ON THE SIMULATION OF RANDOM EXCITATIONS FOR AIRPLANE RESPONSE INVESTIGATIONS ON ANALOG COMPUTERS. Bernard Mazelsky and H. B. Amey, Jr. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 686. 31 pp. Members, $0.65; nonmembers, $1.00. Method of electrical synthesis which uses the output of a noise generator to simulate a random excitation having an arbitrary power spectrum and probability distribution. This excitation can be applied to a dynamic system which is either linear or nonlinear. A description of the method of synthesis is given together with the means for measuring the necessary statistical properties. The method is demonstrated for the simulation of non-Gaussian atmospheric turbulence and its application to the short period response of an airplane over a wide range of frequencies and dampings. Nonlinear aerodynamic restoring force and damping characteristics are also considered.

THE EFFECTS OF FLEXIBILITY ON THE LONGITUDINAL DYNAMIC RESPONSE OF THE B-47 AIRPLANE. H. A. Cole, S. C. Brown, and E. C. Holleman. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 678. 11 pp. Members, $0.35; nonmembers, $0.75. Presentation of the frequency responses of the B-47 elevator control as obtained from NACA flight tests for frequency ranges including the airplane oscillatory short-period mode, the wing first-bending mode, and the fuselage first-bending mode, and comparison of these responses to those predicted by pseudostatic and dynamic analyses. Selection of dynamic degrees of freedom and the apparent disappearance of modes under forced oscillation are discussed in connection with the application of pseudostatic analysis which emphasizes the importance of mass distribution. The frequency response at various points on the airplane is measured and calculated to find optimum locations for automatic-control pickups, and the points of low response to structural vibrations determined in flight are compared with those predicted by dynamic analysis.

VIBRATIONS OF A ROTATING BLADE (ON THE EFFECT OF THE POSITION OF THE CENTRE OF TWIST). Masayuki Ikui. J. Japan Soc. Aero. Eng., Dec., 1956, pp. 3-9. In Japanese. Calculation of the frequencies of the coupled vibrations of a rotating blade having uniform cross section and constant blade angle along its length. Includes derivation of some approximate formulas.

THE ENCOUNTER OF AN AIRFOIL WITH A GUST FIELD. N. P. Hobbs. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 687. 23 pp. 11 refs. Members, $0.65; nonmembers, $1.00. Theoretical consideration of (a) an airfoil entering a moving gust field at an arbitrary rate (not necessarily at the forward speed of the airfoil) and (b) an airfoil instantaneously entering a gust field (or, correspondingly, for a sudden change in angle of attack). Theoretical results for the transient downwash occurring at downstream positions in the plane of the airfoil, as determined for case (a) are compared with appropriate shock-tube data. The effects of finite span and of vertical displacement of the wing are studied for case (b). The downwash is also determined for case (b) and is used to find the resulting lift on a two-dimensional airfoil, representing a horizontal tail, in the plane of the wake - this lift, in turn, being used to evaluate the importance of the downwash in dynamically loading the horizontal tail.

UNSTEADY-LIFT FUNCTIONS FOR PENETRATION OF TRAVELING GUSTS AND OBLIQUE BLAST WAVES. F. W. Diederich and J. A. Drischler. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 714. 17 pp. 10 refs. Members,

$0.35; nonmembers, $0.75. Presentation of the results of some linear-theory calculations of the unsteady lift due to the penetration of sharp-edged traveling gusts. The use of these unsteady-lift functions in other calculations, particularly in connection with blast penetration problems, is discussed.

THE APPLICATION OF ROCKET SLED TECHNIQUES TO FLUTTER TESTING. W. R. Laidlaw and V. L. Belas, Jr. (3rd Annual Supersonic Track Symposium, China Lake, Sept., 1956.) IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 666. 23 pp. Members, $0.65; nonmembers, $1.00. Discussion of the role of rocket sleds in the flutter design process, pointing out that sled testing performs a dual function - a check on the theoretical calculations and a final measure of the margins of safety of a new design. The details of sled design, instrumentation, data reduction, and test procedures are presented. As a part of the discussion, a graphical ballistic method for predicting rocket sizes, firing sequences, and the derived sled performance is outlined.

AIRPLANE PERFORMANCE

A METHOD OF PREDICTING THE AIRBORNE PART OF THE TAKE-OFF DISTANCE OF AN AIRCRAFT. Appendix - ILLUSTRATIVE EXAMPLES. R. B. Tamboli. Can. Aero. J., Jan., 1957, pp. 10-12. Presentation of an empirical piloting-technique formula, derived from the quantitative analysis of the take-off tests of two aircraft, which can be used to predict the minimum practicable airborne distance for a particular value of the ratio of unstick speed to power-on stalling speed. Includes a modification to the piloting technique for estimating the airborne distance under normal (civil) technique.

ELECTRONICS

Wave Propagation

A NEW METHOD FOR CALCULATING SCATTERING WITH PARTICULAR REFERENCE TO THE CIRCULAR DISC. D. S. Jones. Commun. on Pure & Appl. Math., Nov., 1956, pp. 713-746. 16 refs. USAF-supported and sponsored theoretical investigation restricted to the case in which the pressure distribution on the disc depends only on the radius. The purpose of the treatment is to simplify as many aspects of the low-frequency problem as possible. Includes analysis of the problem of the incident plane wave to obtain an approximate solution in good agreement with the spheroidal function solution, and discussion of the case in which the incident wave is supplied by a point source. A general theory - applicable to any obstacle - is derived to show how an upper bound for the scattering coefficient may be determined. The error introduced by the approximation method is also estimated.

FUELS & LUBRICANTS

BUBBLE-POINTS, FLAMMABILITY LIMITS AND FLASH POINTS OF PETROLEUM PRODUCTS. B. P. Mullins. Gt. Brit., NGTE Rep. R. 200, Nov., 1956. 34 pp. 10 refs. Calculation of bubble points, flammability limits, and flash points for four fuels ranging from 100 octane gasoline to marine fuel oil. The mean molecular weight of fuel vapors at the bubble-points is computed, and several nomographic methods of presenting corrected bubble-point data are outlined. Weak and rich flammability limits of fuels in air are calculated over a range of static pressures. The weak limit curve represents the conditions of the closed flash-point test, and by differentiation of this curve a flash-point correction factor is obtained for each fuel.

LIQUID ROCKET PROPELLANTS - IS THERE AN ENERGY LIMIT? J. F. Tormey. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 718. 13 pp. Members, $0.50; nonmembers, $0.85. Discussion of the gains, problems, limitations, and applications of high-energy chemical fuels. Only normal, stable molecules in which the electron orbitals are satisfied and balanced are discussed.

MATERIALS

Metals & Alloys

EFFECT OF FREQUENCY AND TEMPERATURE ON FATIGUE OF METALS. S. R. Valluri. US, NACA TN 3972, Feb., 1957. 15 pp. Qualitative investigation, using a standard linear solid as a physical model, to describe some of the properties of ductile metals under fatigue loading. Results of phenomenological considerations indicate that the critical temperatures observed by Daniels and Dorn and by Valluri are simply temperatures associated with corresponding fatigue-stressing frequencies above which the fatigue behavior changes, rather than real critical values. It is further suggested that the reason why one does not observe the effect of frequency at room temperature in normal engineering practice is that the critical frequency associated with room temperature differs substantially from those frequencies customarily used in fatigue testing.

MATHEMATICS

ON RENEWAL THEORY, COUNTER PROBLEMS, AND QUASI-POISSON PROCESSES. W. L. Smith. Proc. Cambridge Philos. Soc., Jan., 1957, pp. 175-193. 13 refs. OSR-supported analysis to indicate that, apart from certain minor additions to the general theory, the standard machinery of renewal theory leads directly to Hammersley's asymptotic results without recourse to unnatural boundedness conditions. Consideration is also given to two methods of "censoring" a renewal process to yield a new renewal process.

METEOROLOGY

A METHOD FOR EXTRAPOLATING GROUND-BASED RADAR DATA ON RAIN ECHOES TO AREAS OF ARBITRARY SIZE. Isadore Katz. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 720. 19 pp. Members, $0.35; nonmembers, $0.75. Development of a statistical approach to the problem of finding the probability of showery-type precipitation echo existing over preselected smaller areas, given the statistics of echo occurrence within the range of detectability of a radar

set. Use is made of the echo-size probability function, a steering-wind probability function, and an assumption of the independence of echo size and echo speed. Includes illustrations for an X-band radar.

THRESHOLD CONTACT HEIGHT, A SLANT VISIBILITY INDICATION. C. G. Knudsen and W. E. Eggert. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 680. 14 pp. Members, $0.50; nonmembers, $0.85. Operational evaluation of a method for relating ground-station weather observations to conditions the pilot experiences from the cockpit.

MISSILES

THE PREDICTION OF NON-LINEAR PITCHING AND YAWING MOTION OF SYMMETRIC MISSILES. C. H. Murphy, Jr. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 677. 14 pp. 12 refs. Members, $0.50; nonmembers, $0.85. Theoretical investigation of the most general motion of a fourth-order system having constant drag coefficient and constant spin-to-velocity ratio. Analysis is carried out by means of an extension of the Kryloff-Bogoliuboff equivalent linearization technique, the results of which can be presented in the simple, graphic form of an amplitude plane. Only missiles with a plane of mirror symmetry and an angle of rotational symmetry less than or equal to 120° are considered.

THE RESPONSE OF A BISYMMETRIC AIRCRAFT TO SMALL COMBINED PITCH, YAW, AND ROLL CONTROL ACTIONS. R. A. Davis. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 684. 13 pp. 11 refs. Members, $0.50; nonmembers, $0.85. Development of linearized equations of motion of a rolling bisymmetric aircraft using as reference the body axes. It is shown that (a) the rate of change of angle of attack is a vector; (b) a linearized form of downwash-lag terms is valid only if the downwash-roll angle is small; and (c) such a linearized form must use the vector relations of (a). As a result, stability criteria are derived which are independent of the rolling of the reference axis system. The complete solution to the equations is presented for a stepped pitch/yaw control action at a constant roll rate. The complete solution is also given for a variable roll rate, valid only for a simplified system in which the Magnus effect is neglected.

POWER PLANTS

Jet & Turbine

AN AERODYNAMIC SCREEN FOR JET ENGINES. Appendix I - DIMENSIONAL ANALYSIS OF JET DIRECTED AT PLANE. Appendix II - DIMENSIONAL ANALYSIS OF THE BLOWAWAY JET IN OPERATION. Harold Klein. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 676. 19 pp. Members, $0.50; nonmembers, $0.85. Experimental investigation resulting in the development of a downward-directed jet to prevent formation of the vortex responsible for jet ingestion of materials from airport runways. The flow phenomena giving rise to such ingestion, the flow characteristics of the "Blowaway Jet", and the test results on the working device are described. Includes data regarding the necessary air quantities and pressure.

A NEW EXPERIMENTAL APPROACH TO THE ANALYSIS OF COMPRESSOR PERFORMANCE; APPLICATION OF THE BOMELBURG SPARK METHOD TO THE MEASUREMENT OF DIRECTIONAL VELOCITY TRAVERSES AT THE OUTLET OF AN IMPELLER. Josef Herzog. U. Md. Inst. Fluid Dynamics & Appl. Math. TN BN-90 (AFOSR TN 57-3) [AD 115035], Jan., 1957. 15 pp. Transverse measurements of the direction and magnitude of the instantaneous absolute velocity extending across the blade channel at the outlet of a rotating aircraft supercharger impeller. Results give an insight into the qualitative nature of the flow, and indicate that further experience is necessary to determine the attainable accuracy of the method.

AN EXPERIMENTAL INVESTIGATION OF THE BLADE VIBRATORY STRESSES IN A SINGLE-STAGE COMPRESSOR. Appendix I - DETAILS OF MEAN STATIC DENSITY BEFORE TEST STATOR ROW. A. D. S. Carter, D. A. Kilpatrick, C. E. Moss, and J. Ritchie. Gt. Brit., ARC CP 266, 1956. 30 pp. BIS, New York, $0.81. Tests on the untwisted stator of a single-stage compressor carried out in a variable-density return-circuit rig. Results indicate that stalled flutter, apparently identical with that experienced in cascades, occurs in a compressor, particularly at incidences above stall for sufficiently high air velocities; that both the maximum flutter alternating stress and the critical flutter incidence are independent of air density over the range covered, provided the air velocity is sufficiently high; that the critical flutter velocity is a function of air density; and that buffeting stresses are proportional to the steady gas bending stress.

ZUR FRAGE DER ANWENDUNG DES GETRIEBES BEI GASTURBINEN. Nebojša Gašparović. Forschung Gebiete Ing., Ausg. A, No. 6, 1956, pp. 192-196. In German. Calculation, based on simplifying assumptions, of the turbine speed at which a combination of a turbine with a tooth gear reaches the minimum weight. A comparison of the total weight obtained with the weight of the turbine designed without gear shows the cases in which the turbine is to be provided with a gear or rather designed without gear for the given speed of power delivery.

EFFECT OF AMBIENT-TEMPERATURE VARIATION ON THE MATCHING REQUIREMENTS OF INLET-ENGINE COMBINATIONS AT SUPERSONIC SPEEDS. Eugene Perchonok and D. P. Hearth. US, NACA TN 3834, Jan., 1957. 16 pp. Theoretical investigation for two typical turbojet engines up to a Mach Number of 3.5. Results indicate that, with engines designed for constant mechanical speed operation, changes in ambient temperature ordinarily encountered in flight can cause changes of as much as 20 to 30% in either the pressure recovery or the mass flow of the matched inlet-engine combination; that, in order to make use of translating spikes or bypass systems installed for off-design free-stream

Mach Number operation, the inlet should be sized for the lowest ambient temperature to be encountered at the design free-stream Mach Number; and that those fixed-geometry inlet systems which rely on oblique-shock spillage for efficient inlet-engine airflow matching at below-design free-stream Mach Number are heavily penalized when ambient-air temperature variations are considered.

SOME EFFECTS OF TRANSIENTS IN INLET PRESSURE AND TEMPERATURE ON TURBOJET ENGINES. D. S. Gabriel, L. E. Wallner, R. J. Lubick, and George Vasu. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 709. 45 pp. Members, $0.35; nonmembers, $0.75. Results of experiments showing the effect of rapid transients on the stall limits of turbojet engines. It is shown that quasi-steady-state stall limits do not apply. An analytical method is developed for predicting the stall limits and is verified by comparison with experimental data. Examples of computed stall limits for engine operation with diffuser buzz and with ramps in inlet temperature are shown.

Rocket

DYNAMICS OF A VARIABLE THRUST, PUMP FED, BIPROPELLANT, LIQUID ROCKET ENGINE SYSTEM. M. R. Gore and J. J. Carroll. (ARS Semi-Annual Meeting, Cleveland, June 17-21, 1956, Paper.) Jet Propulsion, Jan., 1957, pp. 35-43. Establishment of the principal dynamic characteristics over a broad thrust range by analog-computer simulation of the nonlinear physical elements. Several basic types of control elements are studied and a control system capable of meeting a stringent set of transient performance requirements is synthesized. Transient and frequency response characteristics of the nonlinear system are determined for both small and large changes in thrust level. Results also indicate a correlation between the general nonlinear equations and the linear equations describing the rocket-engine system for perturbations about any fixed thrust level.

QUELQUES POSSIBILITES DES FUSEES A EAU CHAUDE. P. Duban. La Recherche Aéronautique, Nov.-Dec., 1956, pp. 9-16. In French. Theoretical study of the fundamentals of hot-water propulsion, calculation of thermodynamic characteristics, and application to the take-off acceleration as compared with JATO 14 AS-1,000 data.

ROCKETS BURNING PRE-MIXED GASEOUS PROPELLANTS. L. E. Bollinger. Shell Av. News, Dec., 1956, pp. 15-18. WADC-supported investigation of premixing hydrogen-oxygen propellants in order to secure a high rate of heat release from the propellant in the smallest combustion-chamber volume possible so that the engine weight can be minimized. Requirements for producing stable combustion are outlined and a small test engine is described. Several injectors are tested, and one is developed which consists of a converging nozzle in the main flow tube with a small flow of oxygen injected concentrically around the main flow. With this injector it is possible to achieve stable combustion at chamber pressures of 200 and 300 psia and at mixture ratios from stoichiometric to extremely fuel-rich values. Theoretical gas temperature curves and specific thrust curves for the system are presented.

STUDIO TEORICO-SPERIMENTALE DI UN ENDOREATTORE A "LITERGOLO". R. M. Corelli. L'Aerotecnica (Rome), Oct., 1956, pp. 356-364. In Italian. Theoretical and experimental investigation of a lithergol (liquid-solid propellant) rocket. Results of tests in a simple laboratory installation with an open combustion chamber are given along with a description of a special stainless-steel combustion chamber and of experiments on a lithergol propellant (tetranitromethane-carbon) carried out in it.

EFFECT OF DYNAMIC CHARACTERISTICS OF ROCKET COMPONENTS ON ROCKET CONTROL. J. C. Sanders, David Novik, and C. E. Hart. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 710. 19 pp. 16 refs. Members, $0.50; nonmembers, $0.85. Investigation of the dynamic characteristics using an electronic analog computer to study means for reducing the required pump delivery pressure while still maintaining stable operation. The analysis includes the dynamics of fluid pressure transmission through the pump. Results indicate that, because of the low pressure drop, the danger of oscillation is present and the system is sensitive to adverse effects of otherwise insignificant phenomena, such as elasticity of the pump case or the injector. Significant improvements in stability can be achieved by increasing the flow inertia or "inductance" of the propellant lines, provided harmful resonances are avoided. High-frequency control of propellent flow at the injector can remove the instability, thus making possible the selection of an injection pressure drop as low as is consistent with combustion requirements.

THEORETICAL PERFORMANCE OF LIQUID HYDROGEN AND LIQUID FLUORINE AS A ROCKET PROPELLANT FOR A CHAMBER PRESSURE OF 600 POUNDS PER SQUARE INCH ABSOLUTE. Anthony Fortini and V. N. Huff. US, NACA RM E56L10a, Jan. 25, 1957. 38 pp. 10 refs. Calculations of performance for frozen and equilibrium composition during expansion over a wide range of oxidant-fuel ratios. A correlation is given which permits the determination of specific impulse, characteristic velocity, ratio of nozzle-exit area to throat area, chamber temperature, and nozzle-exit temperature for a wide range of chamber pressures.

THEORETICAL ROCKET PERFORMANCE OF JP-4 FUEL WITH MIXTURES OF LIQUID OZONE AND FLUORINE. V. N. Huff and Sanford Gordon. US, NACA RM E56K14, Jan. 28, 1957. 22 pp. 17 refs. Estimation of specific-impulse values by means of a heat-correction equation using data for JP-4 fuel with mixtures of oxygen and fluorine. The estimated values, which are based on equilibrium composition during expansion, are compared with several direct calculations obtained for both equilibrium and frozen composition during expansion.

ROTATING WING AIRCRAFT

A RAPID PERFORMANCE PREDICTION METHOD FOR COMPOUND TYPE ROTORCRAFT. R. D. Foster. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 702. 26 pp. 11 refs. Members, $0.65; nonmembers, $1.00. Application of nomographs to performance calculations based on familiar helicopter theory modified to include the effect of interaction between wings and rotors. A method for determining distribution of the load between the wing and rotor is developed. Provisions are also made for inclusion of the effects of auxiliary power or thrust, which may be available in forward flight, and for calculation of rate of climb, both vertical and maximum.

CORRELATION OF HELICOPTER PERFORMANCE EQUATIONS. I. A. Sikorsky. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 694. 27 pp. 25 refs. Members, $0.65; nonmembers, $1.00. Presentation of a method for the correlation and unification of helicopter performance equations in forward flight. A review is given for the derivations of the equations of motion and blade-element theories, energy and balance of force methods, and combined flapping and feathering. A discussion of the influence of radial flow on profile torque and longitudinal forces is also included. Results show that calculations made by the energy method or by the balance of forces, or by combination of both methods yield identical results only if the same basic assumptions and approximations are used. The correlation is illustrated by diagrams showing mutual interrelation among various parameters.

AN INVESTIGATION OF THE HANDLING QUALITIES OF TANDEM HELICOPTERS. D. F. Gebhard and Leonard Goland. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 704. 19 pp. 11 refs. Members, $0.50; nonmembers, $0.85. Presentation of the equations of motion and stability derivatives for a tandem helicopter in hovering and forward flight. The analysis is applied to obtain time histories for two helicopters and to evaluate a gyroscopic stabilizing bar alone and in conjunction with other simple means for stabilizing tandem helicopters. Criteria for judging the handling qualities of a stabilized helicopter are discussed.

INVESTIGATION OF HELICOPTER BLADE FLUTTER AND LOAD AMPLIFICATION PROBLEMS. H. Daughaday, F. Duwaldt, and C. Gates. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 705. 27 pp. 15 refs. Members, $0.65; nonmembers, $1.00. Theoretical and experimental study which shows that a considerable reduction in bending amplification at resonance can be obtained by coupling the first blade-bending mode with blade pitching. Aerodynamic damping factors for the model bending modes are derived from both forced response and decay data and are compared with those using quasi-static and nonstationary aerodynamic coefficients. The test data substantiates a predicted reduction in damping for integer ratios of oscillation frequency to shaft frequency at low pitch angles. An improvement in agreement between theoretical and test results for a number of pitching-flopping flutter cases is obtained by an empirical reduction in blade circulation.

DIFFERENTIAL EQUATIONS OF MOTION FOR COMBINED FLAPWISE BENDING, CHORDWISE BENDING, AND TORSION OF TWISTED NONUNIFORM ROTOR BLADES. Appendix A - DERIVATION OF LONGITUDINAL STRAINS. Appendix B-DERIVATION OF ACCELERATIONS AND INERTIA LOADINGS. J. C. Houbolt and G. W. Brooks. US, NACA TN 3905, Feb., 1957. 47 pp. 19 refs. Presentation of a theory of such generality that previous theories involving various simplifications are contained in it as subcases. Special attention is given to the terms neglected in previous theories - largely coupling-terms associated with the centrifugal forces. Methods for solving equations of motion are indicated by selected examples.

TABLES OF TWO-DIMENSIONAL OSCILLATING AIRFOIL COEFFICIENTS FOR ROTARY WINGS. R. G. Loewy. Cornell Aero. Lab. Rep. CAL-77, Dec., 1955. 61 pp. 10 refs. Tabulation of unsteady aerodynamic coefficients derived for rotating wings. The complex values of lift deficiency function, section coefficient of lift of the quarter-chord due to plunging motions, and section coefficient of lift at the quarter-chord due to pitching motions about the quarter-chord are tabulated for a sufficient number of combinations of the significant parameters to allow their use in most rotor dynamics problems. The parameters referred to are the reduced frequency familiar in fixed-wing flutter theory, the ratio of oscillatory to rotational frequency, and the rotor inflow ratio.

DIFFERENTIAL DELTA THREE - A METHOD FOR IMPROVING THE LONGITUDINAL STABILITY OF THE TANDEM HELICOPTER. A. C. Adler. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 693. 22 pp. Members, $0.65; nonmembers, $1.00. Discussion of the term differential Δ_3, which has been devised to describe the use of a differential in pitch-cone coupling between the two rotors of a tandem helicopter. An analysis is presented for the effects on the angle-of-attack stability and the control problems associated with the use of this type of system. The differential is such that there will be a greater reduction in pitch with coning on the front rotor. The effect of this artifice is to reduce in forward flight the rate of change of thrust in the fron rotor relative to the rear rotor, which results in an improvement in the angle-of-attack stability. The flight-test program conducted in 1954 is described and time histories of dynamic-stability tests are shown.

INSTRUMENT FLIGHT TRIALS WITH A HELICOPTER STABILIZED IN ATTITUDE ABOUT EACH AXIS INDIVIDUALLY. Seymour Salmirs and R. J. Tapscott. US, NACA TN 3947, Jan., 1957. 17 pp. Flight tests which indicate that heading stabilization provides considerable improvements in calm air, but is actually detrimental under variable wind conditions for the task performed. This latter finding is probably the result of the characteristics of this particular control system. Roll stabilization pro-

vides only minor benefits in calm air and shows no improvements in varying winds. Conversely, stabilization in pitch provides benefits which are significant in both calm air and varying winds.

SPACE TRAVEL

LIFETIMES OF ARTIFICIAL SATELLITES OF THE EARTH. I. G. Henry. (ARS 11th Annual Meeting, New York, Nov. 26-29, 1956, Paper.) Jet Propulsion, Jan., 1957. pp. 21--24, 27. Calculation of the effect of density of the upper atmosphere on the lifetimes of earth satellites in elliptical and circular orbits. It is assumed that this density decays exponentially with altitude. Includes discussion of the physics of drag.

ORIENTATION IN SPACE. M. Vertregt. J. Brit. Interplanetary Soc., Nov.-Dec., 1956, pp. 324-338. Study of spatial navigation which establishes a system of coordinates using the plane of the Earth's orbit around the sun as the reference. The position of a space ship is then determined by its heliocentric longitude and latitude according to the frame of reference and its distance from the sun. Calculations are also made for the shape, and position of the space ship's orbit.

ASCENT OF ORBITAL VEHICLES. K. A. Ehricke. Astronautica Acta, Fasc. 4, 1956, pp. 175-190. Comparison of an ascent into a satellite orbit along a minimum energy ellipse (elliptic ascent) with an ascent along an arc of an elliptic trajectory (ballistic ascent) where the satellite stage is transferred into the orbit at or near the summit. Analyzed are the basic energy requirements, thrust program, effects on the size of the stages, visibility, and the flight times. Basically the ballistic ascent compares unfavorably with the elliptic ascent because of the high transfer energy required at the summit point resulting in the need for transporting comparatively large quantities of material and propellant into orbital distance.

STRUCTURES

Beams & Columns

THE FAILURE OF BOX BEAMS UNDER BENDING AND RAPID HEATING. J. W. Mar. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 716. 19 pp. Members, $0.50; nonmembers, $0.85. Theoretical and experimental investigation of the different modes of failure experienced by a box beam under various combinations of statically applied bending moment and duration of heating time. It is shown how the applied stresses, thermal stress, and elevated temperatures can change the effective edge conditions of the compression cover. The compression cover is considered as a plate with the unloaded edges supported vertically on an elastic foundation and rotationally by torsion springs, both of which change their stiffness characteristics as the beam is heated. Correlation with experimental results of box beams which are heated on one side and loaded by a pure bending moment are shown.

Cylinders & Shells

ON THE THEORY OF THIN ELASTIC SHELLS. P. M. Naghdi. Quart. Appl. Math., Jan., 1957, pp. 369-380. ONR-sponsored derivation of suitable stress-strain relations and the appropriate boundary conditions in the theory of small deformation of thin elastic isotropic shells of uniform thickness. Results, which include the effects of transverse normal stress, transverse shear deformation, and rotary inertia, are deduced by application of a variational theorem due to Reissner.

THE STABILITY OF THIN-WALLED UNSTIFFENED CIRCULAR CYLINDERS UNDER AXIAL COMPRESSION INCLUDING THE EFFECTS OF INTERNAL PRESSURE. L. A. Harris, H. S. Suer, W. T. Skene, and R. J. Benjamin. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 660. 19 pp. 21 refs. Members, $0.50; nonmembers, $0.85. Development of a semiempirical procedure to analyze compressive buckling with a knowledge of the cylinder geometry only. The analysis is achieved by correlating experimental data statistically with theoretical parameters. An extensive series of axial compressive tests of pressurized cylinders has been performed, and these data along with other known test data are utilized for the analysis. Unpressurized and pressurized cylinder compressive buckling curves are then developed as 90% probability curves from the test data. In general, the statistically defined curves are significantly lower than previously available design curves.

NON-LINEAR DEFLECTIONS OF SHALLOW SPHERICAL SHELLS. E. L. Reiss, H. J. Greenberg, and H. B. Keller. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 663. 23 pp. 16 refs. Members, $0.65; nonmembers, $1.00. Application of power series expansions, as used by Friedrichs and Stoker for treating the buckling of circular plates, to derive a solution for Chien's equations for the nonlinear deflections of shallow spherical shells under uniform external pressure. The equations are solved for several ranges of the two parameters upon which they depend, under boundary conditions corresponding to a fixed edge. The solution is carried out numerically on the AEC Univac and yields a complete description of the stresses and deflections as functions of the polar angle. Based on the resulting load vs. deflection curve, a numerical criterion is used to predict the upper buckling load. Includes analysis of post-buckling behavior for some cases.

BUCKLING AND POST-BUCKLING BEHAVIOUR OF A CYLINDRICAL PANEL UNDER AXIAL COMPRESSION. Appendix A - ANALYSIS OF INITIAL POST-BUCKLING BEHAVIOUR OF A NARROW CYLINDRICAL PANEL. Appendix B - FLEXURAL STRAIN ENERGY IN THE STIFFENERS, DUE TO TANGENTIAL BENDING. W. T. Koiter. Netherlands, NLL Rep. S. 476, May 14, 1956. 14 pp. 13 refs. Investigation of a narrow cylindrical panel for one set of boundary conditions along the longitudinal edges. Results indicate that the initial post-buckling stage is stable only for very narrow panels.

A program for further research is outlined with respect to other boundary conditions, to the more advanced post-buckling stage, and to an experimental verification. It is conjectured that the behavior of a narrow curved panel in the advanced post-buckling stage will approach the behavior of a flat panel of the same width.

TAVOLE PER IL CALCOLO DI DISCHI CONICI A SPESSORE SIA DECRESCENTE, SIA CRESCENTE VERSO L'ESTERNO, CON PESO SPECIFICO E TEMPERATURA VARIABILI LUNGO IL RAGGIO. Renato Giovannozzi. L'Aerotecnica (Rome), Oct., 1956, pp. 333-355. In Italian. Tables for the calculation of conical discs whose thicknesses decrease or increase with their radii and whose specific weight and temperature vary along the radius. These tables are based on an exact analytical solution of the hypergeometric equation occurring in the determination of centrifugal and thermal stresses in the conical disc (the thickness of which varies linearly with its radius) for the case of increasing thickness. Includes a numerical example of a gas-turbine disc to illustrate the use of the tables.

Elasticity & Plasticity

PIECEWISE LINEAR ISOTROPIC PLASTICITY APPLIED TO A CIRCULAR CYLINDRICAL SHELL WITH SYMMETRICAL RADIAL LOADING. P. G. Hodge, Jr. J. Franklin Inst., Jan., 1957, pp. 13-33. 19 refs. ONR-sponsored development of a theory of plasticity showing the two classical minimum principles of minimum potential and complementary energy to be valid under certain restrictions on the loading, and application of these principles to an example of an unsupported shell subjected to a given uniform pressure and a given internal ring load. In the development, the plastic potential flow law is extended to include the corners of the yield condition which is expressed in terms of the stress resultants and represented by a square in stress space under the assumption of isotropic and linear strain hardening. The flow law at all points is then piecewise integrated and expressed as a direct relation between stress and strain but containing certain unknown functions.

Plates

NON-LINEAR BENDING OF A CIRCULAR PLATE UNDER NORMAL PRESSURE. Eleazer Bromberg. Commun. on Pure & Appl. Math., Nov., 1956, pp. 633-659. Development of a method, based on boundary-layer theory, for determining the stresses and deformations produced by a uniform normal load on a thin circular plate for a wide range of values of the load and the thickness of the plate. The method circumvents the difficulties associated with the edge effects occurring, for each of the three types of support at the boundary considered, when the load is large and the plate is very thin. Satisfactory approximations to the solution are obtained. Hencky's assumption about the boundary conditions is verified and a procedure, closely following Chien's approach, is indicated for determining the appropriate choice of boundary conditions in similar problems.

TRANSVERSE BENDING OF INFINITE AND SEMI-INFINITE THIN ELASTIC PLATES. I. W. A. Bassali. Proc. Cambridge Philos. Soc., Jan., 1957, pp. 248-255. 11 refs. Application of the complex-variable method to find the appropriate complex potentials and deflection of an infinite thin plate with an inner circular boundary subject to a certain boundary condition introduced by Bassali and Dawoud, with the outer edge free, and loaded over a circular patch - the load being symmetrical with respect to the center of the patch. The limiting case in which the circular boundary degenerates to a straight line is also considered. The solutions given are based on the classical theory of bending of thin plates and are exact within the assumptions underlying this theory.

NON-LINEAR BUCKLING OF CIRCULAR ELASTIC PLATES. Michael Yanowitch. Commun. on Pure & Appl. Math., Nov., 1956, pp. 661-672. Theoretical investigation of two cases of instability of circular elastic plates for which solutions to the appropriate von Kármán nonlinear partial differential equations, used for moderately large deflections of thin elastic plates, have been obtained. The Friedrichs-Stoker and the Bromberg radially symmetric solutions for circular plates are considered. The possibility of second buckling, suggested by Bromberg's solution for the problem of the bending of a circular plate resting on a rigid rim and acted upon by a uniformly distributed vertical force, is formulated and proved, as is Friedrichs and Stoker's conjecture that their solution, derived for the case of a simply supported plate subjected to a uniformly distributed horizontal compressive force, may become unstable if the restriction of radial symmetry is withdrawn and if the edge constraint is sufficiently mild.

ON THE BUCKLING OF AN ELLIPTIC PLATE WITH CLAMPED EDGE. I. Yoshio Shibaoka. J. Phys. Soc. Japan, Oct., 1956, pp. 1,088-1,091. Analysis of the buckling problem of a plate with clamped edge whose periphery is subject to a uniform normal pressure in the plane of the plate. A formal exact solution of the partial differential equation governing the buckling of the plate is obtained by using hyperbolic functions, Mathieu functions, and modified Mathieu functions. An approximate formula for the relationship between the critical buckling load and the eccentricity of the elliptic plate is derived correct to the fourth power of the eccentricity, which is adequate if the eccentricity is not large.

Sandwich Structures

HONEYCOMB SANDWICH CONSTRUCTION FOR SUPERSONIC AIRCRAFT. B. R. Noton. Aircraft Eng., Jan., 1957, pp. 13-18. 22 refs. Survey of materials and methods for sandwich construction. Some rules gathered from experience for the design of components with honeycomb cores and solutions of special design problems with hypothetical wing panels are treated. Applications to a series of components for various hypothetical aircraft are included.

Results are presented for tensile tests on cores, compressive tests on sandwich columns, shear tests on various webs, and tests on the influence of temperature on the shear strength of aluminum core.

BENDING AND BUCKLING OF CLAMPED SANDWICH PLATES. G. A. Thurston. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 662. 11 pp. Members, $0.35; nonmembers, $0.75. Derivation of equations for the deflections and buckling loads of rectangular plates clamped on all four edges, using the Lagrangian multiplier method as applied to Hoff's energy expressions for sandwich plates. Numerical calculations are performed to find the buckling coefficients. These are plotted for use as design curves and show the reduction in buckling load due to shear in the core. Although the method is approximate in theory, the convergence is rapid. The calculations are carried out on an IBM 704 computer which makes an essentially exact solution possible.

Thermal Stress

METHODS FOR REDUCTION OF HIGH TEMPERATURE DATA IN TERMS OF A THEORY OF DEFORMATION. K. F. A. Walles. Gt. Brit., NGTE Memo. M.242, Dec., 1956. 41 pp. Description of procedure for the analysis of creep curves, creep rupture data, and hot fatigue data. Rapid graphical methods are presented with an accuracy which is compatible to the data presently available. The methods coordinate and summarize experimental data upon convenient graphs of stress versus a time-temperature variable from which values of strain for any combination of stress, time, and temperature within the experimental range may be immediately read by means of a sliding scale.

INSTATIONÄRE WÄRMESPANNUNGEN IN EINER HOHLKUGEL. R. Trostel. Ing.-Arch., No. 6, 1956, pp. 373-391. In German. Investigation of the state of stress produced by rotationally symmetric temperature fields in hollow spheres whose internal and external surfaces are under the influence of thermal edge effects.

ON THE STEADY-STATE THERMOELASTIC PROBLEM FOR THE HALF-SPACE. E. Sternberg and E. L. McDowell. Quart. Appl. Math., Jan., 1957, pp. 381-398. 23 refs. Theoretical investigation to determine the steady-state thermal stresses and displacements in a semiinfinite elastic medium bounded by a plane. An exact closed solution, in terms of complete and incomplete elliptic integrals of the first and second kind, is derived for a circular region of exposure at uniform temperature. Exact solutions are also obtained, in terms of elementary functions, for a hemispherical distribution of temperature over a circular region and for a rectangle at constant temperature. The problem is treated within the classical theory of elasticity and is approached by Green's method.

Weight Analysis & Control

PROBLEMS IN ESTIMATING STRUCTURE WEIGHTS. M. G. Heal. (Soc. Aero. Weight Engr., Meeting, Los Angeles, Sept. 26, 1956.) Aero. Eng. Rev., Mar., 1957, pp. 52-56. Methods are presented for estimating weights of high-speed aircraft and the parameters which influence these weights, with emphasis on low-aspect-ratio unswept wings. The loads are caused by flight maneuvers, gusts, and ground handling, with the first being the most critical for fighter aircraft. The maneuver-load factor is given either by regulation or by studying the aerodynamic capabilities of the airplane required at the critical point of the mission. Formulas are presented for estimating gust-load limit factor, airload distribution, wing weight, and aeroelastic effects.

THERMODYNAMICS

Combustion

THE CURRENT STATUS OF RESEARCH ON TURBULENT COMBUSTION IN PREMIXED GASES. R. R. John. ARDE Associates, New Jersey, TR 4555-1 (AFOSR TR 5659) [AD 115004], Nov., 1956. 15 pp. 34 refs. Review of the combustion research which indicates that there is a spectrum of different possible mechanisms governing the effect of turbulence on the reaction zone. The different mechanisms are identified with the wrinkled laminar flame, the zone of extended reaction, and the zone of instantaneous mixing. Major emphasis is placed on a discussion of the zone of extended reaction. It is suggested that the difference between various mechanisms of turbulent combustion preclude the possibility of obtaining a simple quantitative theory of turbulent flame propagation in premixed gases.

FLAME STABILIZATION IN A BOUNDARY LAYER. H. C. Hottel, Tau-Yi Toong, and J. J. Martin. (ARS Fall Meeting, Buffalo, Sept. 24-26, 1956, Paper.) Jet Propulsion, Jan., 1957, pp. 28-30, 48. Examination of the theory of flame stabilization performed by investigating the stability of a lean propane-air flame in the boundary layer along a water-cooled slender rod whose longitudinal axis lies at the center of a large Pyrex duct. Results indicate that, except within 2 in. of the duct exit, the stable flame position is determined by the flow characteristics in the boundary layer along the rod, and that the distance between the flame and the leading edge of the rod decreases as the free-stream mixture velocity increases and the propane-air ratio increases from lean toward the stoichiometric value. The velocity gradient at the rod surface is calculated and correlated with the propane-air ratio for a given coolant temperature.

Heat Transfer

HEAT TRANSFER AT SMALL GRASHOF NUMBERS. J. J. Mahony. Proc. Royal Soc. (London), Ser. A, Jan. 8, 1957, pp. 412-423. Investigation of heat transfer from a body immersed in a fluid whenever the Grashof number (G) is small. It is shown that while convection is negligible in comparison with conduction near the body, it becomes important at distances from the body of the order $(G)^{-n}$, where n varies between 1/3 and 1/2 with the body shape. Whenever this distance is large in com-

parison with all the dimensions of the body, the use of the conduction equation yields correct heat-transfer rates. If, however, this distance is small in comparison with the body length, the heat transfer may be calculated from the two-dimensional convection solution.

VTOL & STOL

EVALUATION OF VTOL SYSTEMS SUITABLE FOR TRANSPORT AIRCRAFT. W. Z. Stepniewski and Joseph Mallen. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 724. 19 pp. 12 refs. Members, $0.50; nonmembers, $0.85. Consideration of the payload-carrying abilities, the effects of altitude and ambient temperature in hovering, cruising speed, and altitude in forward flight in connection with the tilt-wing propeller, deflected slipstream, tilting ducted-propeller, hover-jet, Vertodyne, and Vectodyne types of VTOL aircraft. Includes analyses of the conventional helicopter and the STOL aircraft. Areas requiring more research are indicated for the particular VTOL systems, and the advantage of using test beds for further investigation is emphasized.

PROBLEMS OF STABILITY AND CONTROL FOR VTOL AIRCRAFT. J. A. O'Malley, Jr. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 729. 23 pp. Members, $0.65; nonmembers, $1.00. Study of the take-off and landing characteristics and stability of both fixed- and rotating-thrust VTOL-STOL aircraft. Jet-airframe characteristic equations are derived and various control systems are considered. Results indicate that the stability characteristics of the rotating-thrust horizontal-attitude VTOL aircraft are inherently superior in the constant-altitude transition; that steady wind and gust action are vital factors which can be used to advantage if sufficient emphasis is placed on stability and control during VTOL design; and that a heavily damped short-period longitudinal oscillation will gyroscopically couple with the lightly damped "dutch roll" oscillation to improve the lateral directional characteristics of a jet VTOL aircraft in normal flight.

TAKE-OFF AND LANDING DISTANCE AND POWER REQUIREMENTS OF PROPELLER-DRIVEN STOL AIRPLANES. R. E. Kuhn. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 690. 19 pp. Members, $0.50; nonmembers, $0.85. Discussion of some of the factors, other than the performance of the airplane, which place a lower limit on the achievable landing distances. Includes description of procedures for calculating the power requirements in the transition speed range and for indicating propeller efficiencies which vary continuously from the static-thrust figure of merit at zero speed to the normally used propeller efficiency at high speeds. Treatment illustrates the effects of wing stall on power requirements and take-off and landing distances in the transition speed range. It is shown that the proper choice of wing size and propeller disc area, flaps (possibly in combination with wing tilt), and the addition of a slat can all be used or combined to achieve a considerable measure of control over the wing stall.

EFFECTS OF WING POSITION AND VERTICAL-TAIL CONFIGURATION ON STABILITY AND CONTROL CHARACTERISTICS OF A JET-POWERED DELTA-WING VERTICALLY RISING AIRPLANE MODEL. P. M. Lovell, Jr., and L. P. Parlett. US, NACA TN 3899, Jan., 1957. 35 pp. Investigation on three model configurations: a high wing with a top-mounted vertical tail, a high wing with top- and bottom-mounted vertical tails, and a low wing with top-mounted vertical tail. Results show that transition flights for a high wing configuration with top-mounted tail are difficult to accomplish without automatic stabilization because of lateral divergence which occurred between angles of attack of 50° to 60°. No successful transition flights were made, even with roll dampers, on a high wing configuration with both top- and bottom-mounted tails because of an uncontrollable rolling devergence at low airspeeds. Also for a low wing, top-mounted vertical tail configuration, no successful transition flights were made without artificial damping.

EFFECT OF PROPELLER LOCATION AND FLAP DEFLECTION ON THE AERODYNAMIC CHARACTERISTICS OF A WING-PROPELLER COMBINATION FOR ANGLES OF ATTACK FROM 0° TO 80°. W. A. Newsom, Jr. US, NACA TN 3917, Jan., 1957. 45 pp. Theoretical and experimental investigation to determine the lift, drag, and pitching-moment of a propeller-wing combination with propellers widely spaced over the span. Data are obtained for flap deflections of 0°, 20°, 40°, and 60° with the slat off and on. The results indicate that with proper propeller position and programming of flap deflection, it is possible to design a tilting wing configuration in which essentially no change in trim is required throughout the transition from hovering to normal unstalled forward flight.

INVESTIGATION OF EFFECTIVENESS OF A WING EQUIPPED WITH A 50-PERCENT-CHORD SLIDING FLAP, A 30-PERCENT-CHORD SLOTTED FLAP, AND A 30-PERCENT-CHORD SLAT IN DEFLECTING PROPELLER SLIPSTREAMS DOWNWARD FOR VERTICAL TAKE-OFF. R. E. Kuhn. US, NACA TN 3919, Jan., 1957. 39 pp. Test results which indicate that with proper setting of the flaps and slat a turning angle of about 70° is obtained both in and out of the ground-effect region; but the ratio of resultant force to thrust varies from about 1.00 with the model in the position nearest the ground to about 0.86 out of the ground-effect region. With the slat installed, the model could be trimmed in pitch with the center of gravity located at 42% chord.

WATER-BORNE AIRCRAFT

STRUCTURAL AND IMPACT LOADS FOR THE FLEXIBLE AIRPLANE DURING WATER LANDINGS. Edward Widmayer, Jr. IAS 25th Annual Meeting, New York, Jan. 28-31, 1957, Preprint 689. 19 pp. Members, $0.50; nonmembers, $0.85. Development of a calculation method which takes into account the dependence of impact loads on rate of descent, trim angle, landing speed, hull shape, and the degree of flexibility of the entire airplane. The last parameter is given particular attention. Calcu-

lations are made for both a rigid and a flexible airplane. Results are compared with experimental measurements of both the hull bottom loads and the acceleration response of the M-270 aircraft.

SAUNDERS-ROE PRINCESS FLYING BOAT G-ALUN AIR AND WATER PERFORMANCE TESTS. Appendix I---ENGINE PERFORMANCE ANALYSIS. Gt. Brit., ARC CP 279, 1956. 39 pp. BIS, New York, $0.99. Results indicate that the basic air-drag characteristics are better than those achieved on previous British flying boats; that there is a measurable change with slipstream, both in basic profile drag and induced drag; and that during take-off, with the derated engines, the minimum longitudinal acceleration at the maximum-drag (hump) speed in up to 1-ft./sec.^{2} sea conditions is 2.04 ft./sec.^{2} (0.063g) at an aircraft weight of 295,000 lbs. Using the associated mean engine output derived from the single-engine torquemeters, the propeller thrust is calculated from the manufacturer's performance curves in order to approximate the maximum total resistance value.

IMPACT-LOADS INVESTIGATION OF CHINE-IMMERSED MODELS HAVING CONCAVE-CONVEX TRANSVERSE SHAPE AND STRAIGHT OR CURVED KEEL LINES. P. M. Edge, Jr. US, NACA TN 3940, Feb., 1957. 66 pp. Tests over a wide range of trim and initial flight-path angles conducted primarily in smooth water with landing impacts made at a beam-loading coefficient of 18.77. Includes a few tests with impacts at beam-loading coefficients of 27.39 and 36.15 and a few curved-bow impacts in rough water. Experimental data are presented in tables and the derived coefficients of loads and motions are presented in figures as the variation with initial flight-path angle.

WIND TUNNELS & RESEARCH FACILITIES

PRELIMINARY STUDIES, DESIGN AND THEORY, FOR THE OHIO STATE UNIVERSITY HYPERSONIC WIND TUNNEL. Appendix A - ESTIMATION OF THE HEAT TRANSFER OF THE SPIRAL - COIL HEATING ELEMENT. J. D. Lee and G. L. Von Eschen. Appendix B - STUDY OF THE BOUNDARY LAYER IN THE AXISYMMETRIC HYPERSONIC 3-INCH NOZZLE. S. T. Chu. Ohio State U., Res. Found. TR 1, Aug., 1956. 86 pp. 20 refs. Development of a hypersonic tunnel having an axially-symmetric free jet and an 8-in. nozzle-exit diameter, and capable of being operated continuously at stagnation temperatures up to 2,750° R. with stagnation pressures up to 4,000 psia within the range $8<M<15$. Preliminary studies and experimental results are given for a model heater and for a 3-in. diameter pilot model wind tunnel, along with details of the design and the expected performance of the primary wind tunnel. Theoretical considerations of real gas effects for the operating range of the primary tunnel are also analyzed, and a theory is presented to account for variations in specific heats.

A STORAGE-TYPE AIR HEATER FOR AN INTERMITTENT-FLOW SUPERSONIC WIND TUNNEL. Appendix I - COMPARISON OF HEAT RELEASE CHARACTERISTICS OF HEAT STORAGE MATERIALS. Appendix II - ESTIMATE OF TEMPERATURE DROP ALONG STORAGE HEATER LENGTH DURING HEATING-UP PHASE. J. E. Weiler. Texas U., DRL Rep. 393 (AFOSR TN 56-572) [AD 110394], Nov. 7, 1956. 76 pp. 11 refs. Development of an air heater for supplying the bulk of heat to the air supply of a 6 x 6 in. blowdown wind tunnel. The heater is of the regenerative type in which a packing of ferrosilicon spheres constitutes the heat storage medium. Manifold connections at each end of the heat sections facilitate alternate arrangements of flow paths best suited for the conditions of operation at Mach Number of 2.0 or 5.0.

FACTORS AFFECTING THE PERFORMANCE OF THE NOZZLE OF A HYPERSONIC SHOCK TUBE. B. D. Henshall and G. E. Gadd. Gt. Brit., ARC CP 293, 1956. 29 pp. BIS, New York, $0.81. Theoretical investigation of the starting process of a hypersonic shock tube and evaluation, for various static temperatures and flow Mach Numbers, of the subsequent flow conditions in the working section. A discussion of the simulation of free-flight conditions leads to recommendations and appropriate performance charts for the optimum operation of hypersonic shock tubes.

MODEL INSTRUMENTATION TECHNIQUES FOR HEAT TRANSFER AND FORCE MEASUREMENTS IN A HYPERSONIC SHOCK TUNNEL. Appendix I - A FIRST-ORDER SOLUTION FOR THE HEAT TRANSFER RATE. R. J. Vidal. USAF WADC TN 56-315 [AD 97238], Feb., 1956. 76 pp. 22 refs. Development of instrumentation for a shock tunnel taking into account the short total testing time and the occurrence of nonsteady flow in the usable testing time. A description is given for a balance system and a resistance thermometer for making transient-force and heat-transfer measurements under these conditions. Performance of a thin metal resistance thermometer mounted on an insulating body is analyzed and methods are given for contracting this instrument. Experimental results which were obtained in subsonic flow generated in a shock tube are presented. An accelerometer balance system is described and its performance analyzed.

SIMILARITY CONDITIONS FOR TESTING HIGH SPEED AIRCRAFT MODELS. Lu Ting. Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech., PIBAL Rep. 308 (AFOSR TN 56-548) [AD 110367], Nov., 1956. 50 pp. 10 refs. Establishment of conditions for the simultaneous simulation of the flow field, the temperature distribution, and the deformation of an airplane or one of its components in free flight at high speeds. Analysis is carried out for the case where the same gas (air) in the free-flight condition is used for the wind-tunnel test but the stagnation temperature is different, i.e., the temperature scale is not necessarily equal to unity. It is shown that, for specific problems, approximations can be introduced which are justified by facts or mathematical arguments. The concept that the number of similarity conditions can thus be reduced is applied to the design of a small-scale model of a planar wing of low aspect ratio.

pp. 67, 68. 12 refs. Method to reduce drag on triangular wings by optimizing a five-term series of a purely conical family. The calculations are based on a set of assumed shapes, each of which causes infinite velocities around the leading edge, resulting in a suction force operating in opposition to the drag.

Unsteady Flow Around Thin Wings at High Mach Numbers. Marten T. Landahl. *J. Aero. Sci.*, Jan., 1957, pp. 33–38. Expansion in a series of M^{-2} of the perturbation velocity potential for unsteady flow around thin wings, taking into account linear and second-order terms in perturbation velocities. Includes a calculation for the simple case of two-dimensional bending-torsion flutter.

Lift and Pitching-Moment Interference Between a Pointed Cylindrical Body and Triangular Wings of Various Aspect Ratios at Mach Numbers of 1.50 and 2.02. Appendix A—Derivation of Corrections for Stream Nonuniformities. Jack N. Nielsen, Elliott D. Katzen, and Kenneth K. Tang. *U.S., NACA TN 3795*, Dec., 1956. 49 pp. 14 refs.

Optimum Thickness and Lift Distribution for a Fuselage in the Presence of a Prescribed Wing System. M. E. Graham. *J. Aero. Sci.*, Feb., 1957, pp. 142–144. 11 refs.

Base Pressure at Supersonic Speeds on Two-Dimensional Airfoils and on Bodies of Revolution with and Without Fins Having Turbulent Boundary Layers. Eugene S. Love. *U.S., NACA TN 3819*, Jan., 1957. 65 pp. 37 refs. Analysis of available experimental data to show the effects of most of the variables that are predominant in determining base pressure at supersonic speeds.

Experimental Determination of the Range of Applicability of the Transonic Area Rule for Wings of Triangular Plan Form. William A. Page. *U.S., NACA TN 3872*, Dec., 1956. 22 pp. Investigation to determine the zero-lift drag rise at transonic speeds of a family of triangular plan-form wings of varying thickness and aspect ratio, mounted on a cylindrical body.

Aeroelasticity

On Aeroelastic Solutions. William J. Gaugh and Joseph K. Slap. *J. Aero. Sci.*, Jan., 1957, pp. 76, 77. Simplified method for estimating aeroelastic effects on aircraft lateral stability and control.

Approximate Energy and Equilibrium Equations for Cylindrical Shells. E. H. Kennard. *J. Appl. Mech.*, Dec., 1956, pp. 645, 646.

The Reflection of Transverse Waves in Beams. R. P. N. Jones. *Quart. J. Mech. & Appl. Math.*, Dec., 1956, pp. 499–507. 10 refs. Derivation of a theory for determining the reflections of an incident wave at a beam end, with discussion of the propagation and reflection of a flexural pulse.

The Natural Frequencies of Thin Skew Plates. R. K. Kaul and V. Cadambe. *Aero. Quart.*, Nov., 1956, pp. 337–352. Calculation of the natural frequencies of thin isotropic rhombic plates with three possible combinations of boundary conditions, obtained by combining clamped-clamped and clamped-supported edge conditions.

Transient Response of a Nonlinear System by a Bilinear Approximation Method. E. I. Ergin. (*ASME West Coast Conf., Appl. Mech. Div., Pasadena, June 11–13, 1956.*) *J. Appl. Mech.*, Dec., 1956, pp. 635–641. Development of a line-segment approximation for a nonlinear elastic force which makes it possible to obtain analytical solutions to a number of transient-load problems formerly solvable only by graphical or numerical methods.

Incomplete Time Response to a Unit Impulse and Its Application to Lightly Damped Linear Systems. James J. Donegan and Carl R. Huss. *U.S., NACA TN 3897*, Dec., 1956. 17 pp. Study of the use of the incomplete time impulse response to a unit impulse as a device to analyze lightly damped linear systems. The incomplete response may be used with Duhamel's integral to predict the response of the system to an arbitrary input up to at least 90 per cent of the cutoff time of the incomplete response.

Experimental and Predicted Lateral-Directional Dynamic-Response Characteristics of a Large Flexible 35° Swept-Wing Airplane at an Altitude of 35,000 Feet. Appendix A—Predicted Airplane Response. Appendix B—Example Calculation of Wing Contribution to Cl_β Using Aerodynamic and Structural Influence Coefficients. Stuart C. Brown and Euclid C. Holleman. *U.S., NACA TN 3874*, Dec., 1956. 74 pp. 14 refs.

ANOTHER Bendix ACHIEVEMENT

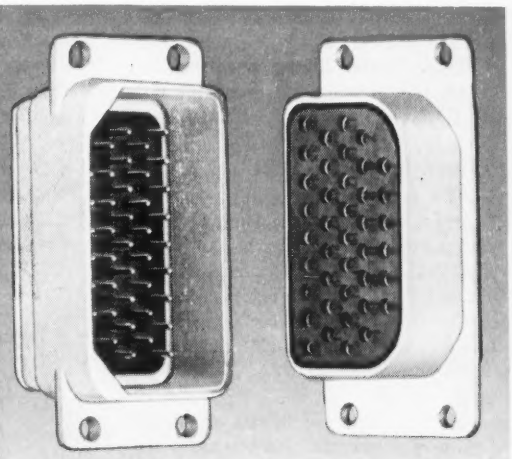
A resilient insert rack and panel connector

Here is the new and improved Bendix Type SR rack and panel electrical connector with outstanding resistance to vibration. The low engagement force of this connector gives it a decided advantage over existing connectors of this type.

Pressurization is easily accomplished. The resilient inserts press firmly against the shell wall holding the contacts in exact position. Insert patterns are available to mate with existing equipment in the field.

Adding to the efficiency of this rack and panel connector is the performance-proven Bendix "clip-type" closed entry socket.

Here, indeed, is another outstanding Bendix product that should be your first choice in rack and panel connectors.



OUTSTANDING FEATURES

Resilient Insert • Solid Shell Construction • Low Engagement Forces • Closed Entry Sockets • Positive Contact Alignment Contacts — heavily gold plated • Cadmium Plate—clear irridite finish • Temperature range —67° to +250°F. • Easily Pressurized to Latest MIL Specifications.

Bendix SCINTILLA DIVISION of SIDNEY, NEW YORK Bendix AVIATION CORPORATION

Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

FACTORY BRANCH OFFICES:

117 E. Providencia Ave., Burbank, Calif. • 120 W. Second St., Dayton 2, Ohio • Paterson Building, 18038 Mack Ave., Detroit 24, Mich. • 2608 Inwood Road, Dallas 19, Texas • 5906 North Port Washington Rd., Milwaukee 17, Wisc. • Boeing Field, Seattle 8, Washington • Hulman Building, 1701 "K" Street, N.W., Washington 6, D. C.

Service Strength, a Basis for the Design of Components Exposed to Randomly Alternating Loads. E. Gassner. (*Konstruktion*, No. 3, 1954, pp. 97–104.) *Gt. Brit., RAE Lib. Transl. 575*, July, 1956. 16 pp. 41 refs. Discussion of the principles and some of the results of service-strength testing, in which a load program, approximated by a Pascal distribution is reproduced by a discontinuous distribution of "load stages" in a new form of fatigue test for components and assemblies.

Some Measurements of Aerodynamic Forces and Moments at Subsonic Speeds on a Wing-Tank Configuration Oscillating in Pitch About the Wing Midchord. Appendix A—**Correction of Root Reaction for Inertia and Aeroelastic Effects to Determine the Total Aerodynamic Load.** Appendix B—**Determination of the Aerodynamic Damping-Moment Coefficient.** Sherman A. Clevenson and Sumner A. Leadbetter. *U.S., NACA TN 3822*, Dec., 1956. 37 pp.

On the Torsional Oscillations of a Solid Sphere in a Viscous Fluid. G. F. Carrier and R. C. Di Prima. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 601–605. ONR-sponsored theoretical investigation taking into account the motion in planes containing the axis of oscillation.

Results of Two Free-Fall Experiments on Flutter of Thin Unswept Wings in the Transonic Speed Range. William T. Lauten, Jr., and Herbert C. Nelson. *U.S., NACA TN 3902*, Jan., 1957. 20 pp. Application of the bomb-drop method to obtain flutter data for four nearly identical thin, unswept wings. Two wings fluttered at $M = 0.85$, one at $M = 1.03$, and the last at $M = 1.07$.

Ill-Conditioned Flutter Equations and Their Improvement for Simulator Use. E. G. Broadbent. (*Gt. Brit., RAE TN Struc.195*, June, 1956.) *Gt. Brit., ARC CP 298*, 1956. 22 pp. BIS, New York, $0.63.

An Investigation of the Flutter of Rectangular Wings with Tip Masses. II—Test Vehicle Design, Instrumentation and Firing. Appendix I—**Wing Construction Techniques.** Appendix II—**Clamp Design and Fitting.** R. J. Rockliff. *Australia, WRE/HSA6 ARL/SM239*, Feb., 1956. 30 pp. 10 refs.

An Investigation of Effects of Certain Types of Structural Nonlinearities on Wing and Control Surface Flutter. Donald S. Woolston, Harry L. Runyan, and Robert E. Andrews. (*IAS 24th Annual Meeting, New York, Jan. 23–26, 1956, Preprint 633.*) *J. Aero. Sci.*, Jan., 1957, pp. 57–63.

Supersonic Flutter of a Cylindrical Shell. John W. Miles. (*Ramo-Wooldridge Corp. Rep. GM-TR-32*, May 25, 1956.) *J. Aero. Sci.*, Feb., 1957, pp. 107–118. 18 refs. Abridged. Theoretical investigation of the aerodynamic instability of traveling waves on a cylindrical shell exposed to an external supersonic air stream and containing an internal fluid. Analysis is based on the hypothesis of a short wave length (compared with the radius and length of the shell). The stability criterion for an empty isotropic shell and the negative damping ratio when this criterion is not met are determined.

Influence of Large Amplitudes on Free Flexural Vibrations of Rectangular Elastic Plates. Hu-Nan Chu and George Herrmann. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 532–540.

An Approximate Method Applied to the Solution of the Problem of Vibrating Rectangular Plates. Milomir M. Stanšić. *J. Aero Sci.*, Feb., 1957, pp. 159, 160.

Vibration of Clamped Parallelogrammic Isotropic Flat Plates. M. Hasegawa. *J. Aero. Sci.*, Feb., 1957, pp. 145, 146. Calculation of the smallest frequency of the vibration by the Ritz method for rectangular plates.

Myklestad's Method for Non-Uniform Vibrating Beams. I, II. R. E. D. Bishop. *The Engr.*, Dec. 14, 21, 1956, pp. 838–840; 874, 875. 12 refs. Presentation of simplified tables for Myklestad's extension to the flexural motion of beams of Holzer's method for investigating torsional vibration. The method is shown to be essentially a means of calculating the receptances of beams.

Dynamic Equations of Donnell's Type for Cylindrical Shells with Application to Vibration Problems. Yi-Yuan Yu. *Syracuse U., Res. Inst. Mech. Eng. Dept. Rep. ME390–5610TN1(AFOSR TN 56–526) [AD 110345]*, Oct., 1956. 26 pp. Derivation of two sets of equations—the first set from the Flügge equations, which neglect transverse-shear and rotational-inertia effects; the second set from equations which include these effects.

Electronic Analog Computer Solutions of Nonlinear Vibratory Systems of Two Degrees of Freedom. C. P. Atkinson. (*ASME West Coast Conf., Appl. Mech. Div., Pasadena, June 11–13, 1956.*) *J. Appl. Mech.*, Dec., 1956, pp. 629–634.

Gust Research with V-g Recorders on Australian Routes. F. H. Hooke and Queenie Baum. *Australia, ARL Rep. SM.241*, Apr., 1956. 123 pp. 14 refs.

Mathematical Analysis and Analog Simulation of Atmospheric Turbulence Gust Velocities. Julius S. Bendat. *J. Aero. Sci.*, Jan., 1957, pp. 69, 70.

Aeronautics, General

Air Transportation. Theodore P. Wright. *Israel Soc. Aero. Sci., First Biennial Lecture, Paper* Dec., 1956. 70 pp. 28 refs. Survey of the air transportation industry today and discussion of its future development.

Research, Development and Technical Issues. Arnold Hall. *Flight*, Dec. 28, 1956, pp. 994–997.

Special Issue: 1957 Buyers' Guide Edition. *Av. Week*, Mid-Dec., 1956. 361 pp. Alphabetical compilation of products and manufacturers of the aviation industry, including aircraft and missile systems, avionics, air-line and airport equipment, and nuclear systems.

Air Transportation

The Aircraft Assignment Problem. Ram Vaswani. *Aero. Eng. Rev.*, Feb., 1957, pp. 64–68. Application of Flood's optimal assignment technique of linear programing to the air-line industry.

How Local Airlines Serve America. *Esso Air World*, Sept.-Oct., 1956, pp. 30–39. Includes specific data on each of the 13 local air lines recently given permanent certification.

Airplane Design

The Aerodynamic Efficiency of Tubular Fuselages. Luigi Stipa. (*L'Aerotecnica*, Mar., 1932.) *Miss. State Coll., Aerophys. Dept.*, Aug. 22, 1956, Reprint. 32 pp. Translation. Test results for a series of tubular fuselage models in which the external shape is held constant while the internal longitudinal section is varied. The coefficients of lift and drag are compared for ordinary and tubular fuselages.

Strahlturbinenflugzeuge im Luftverkehrsbetrieb. G. Höltje. *Luftfahrttechnik*, Aug. 15, 1956, pp. 142–148. In German. Evaluation of the application of jet-turbine aircraft to air transport.

Weapon System Management Mates B-58 Airframe and Electronics. August C. Esenwein. *Av. Age*, Jan., 1957, pp. 34, 35–39 ff.

Das schwedische Jagdflugzeug Saab J 35 "Draken." Alfred Aepli. *Flugwehr und -Technik*, Dec., 1956, pp. 334, 335. In German. Design and description of the Swedish fighter plane Saab J 35 "Draken."

Wind Tunnel and Flight Tests Prove Out Caravelle's Rear-Fuselage Nacelles. Marcel Duguet. *Av. Age*, Jan., 1957, pp. 62–67 ff.

F-102 is Built Around Its Electronics System. Irwin Stambler. *Av. Age*, Jan., 1957, pp. 26, 27–31 ff. Discussion of the design problems encountered by Hughes and Convair engineers in building the delta-wing F-102 interceptor.

Militärische Typenbezeichnungen von Flugzeugen der Sowjetunion. *Flugwelt*, Dec., 1956, pp. 841, 843. In German. Listing of military designation of Soviet aircraft types.

Neuartige Herstellungsmethoden beim Bau des Glenn Martin Flugbootes XP6M1 mit Strahltriebwerken. Arno Fischer. *Flugwelt*, Dec., 1956, pp. 801–803. In German. Evaluation of new manufacturing techniques in the construction of the Glenn Martin Jet Flying Boat XP6-M-1.

A4D's Simplified Design Proves Out in Navy Tests. Irwin Stambler. *Av. Age*, Dec., 1956, pp. 26, 27, 28–31 ff. Design details of the aircraft which is capable of carrying bombs, rockets, or fuel in its racks.

Trying Out the Tracker. Antony Verrico. *Aircraft (Canada)*, Nov., 1956, pp. 86–88, 115. Discussion of performance characteristics and operation of the Canadian-built CS2F-1, twin-engine, anti-submarine aircraft.

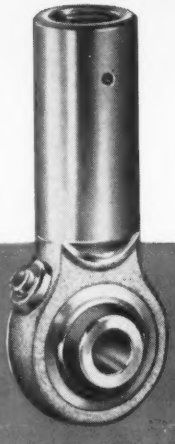
Test of Friendship. C. M. Lambert. *Flight*, Dec. 28, 1956, pp. 987–990. Discussion of the performance and handling qualities of the new Fokker turboprop transport aircraft.

Método de Inspección Optica para Cabinas Transparentes. E. A. Kops and W. A. Heitzman. *Rev. Aérea Latinoamericana*, Sept., 1956, pp. 3, 4, 6–8. In Spanish. Description of a method of inspection,

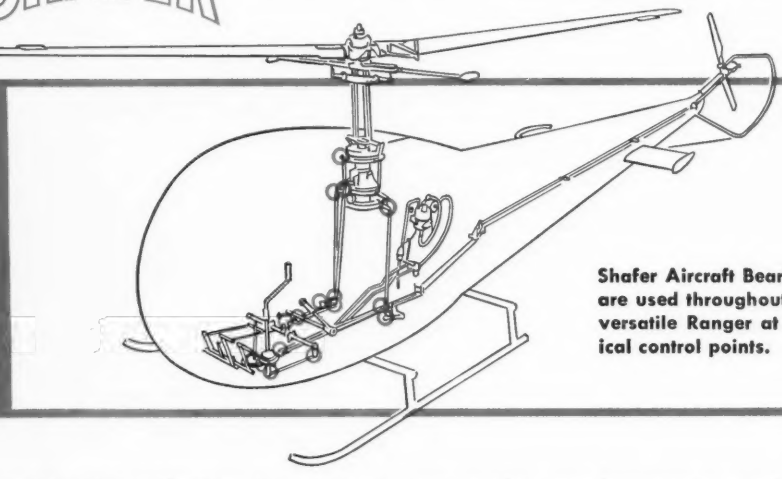
Newest of the famous Bell Model 47 family, the Ranger cruises with its four passenger load at more than 90 m.p.h.

for the toughest control applications

SHAFER® AIRCRAFT BEARINGS



YS-112, one of the many C.A.A.-approved Shafer Bearings used on the Bell Model 47J.



Shafer Aircraft Bearings are used throughout the versatile Ranger at critical control points.

Toughest of all aircraft bearing applications is in the control system of rotary wing aircraft.

Constant vibration, continually varying in-flight deflections of structural members, oscillatory loads, shock loads—all combine to call for the utmost in bearing performance.

Shafer Bearings are specified by Bell engineers because they provide full capacity under all these conditions at all degrees of misalignment to plus or minus 10°. Regardless of size, Shafer Bearings deliver the performance and the greatest load capacity for envelope dimensions and weight—greater than any other self-aligning anti-friction bearings available today!

Shafer rollers align themselves naturally, eliminating roller end wear and race surface scuffing—insuring unrestricted radial capacity under all conditions.

All Shafer Aircraft Bearings provide for relubrication in service—without disassembly or removal from the aircraft structure—of special importance for long life in helicopter applications. This original Shafer feature makes it practical and easy to extend service life three to ten times that of bearings not relubricated.

There is much more to a Shafer Bearing—and you'll want the whole story. Write for Catalog 54. CHAIN Belt Company, Shafer Bearing Division, 801 Burlington Ave., Downers Grove, Ill.

SHAFER® CHAIN BELT COMPANY

ROCKET POWER PROGRESS REPORT

Tailoring Molecules *for* Rockets

by Dr. David Z. Lippmann

A member of the Chemistry Department Staff at Reaction Motors, Inc., Dr. Lippmann specializes in combustion processes and theoretical analysis. He received his B. S. and M. A. in Chemistry at the University of Texas and his Ph. D. in Physical Chemistry at the University of California at Berkeley. He has been with RMI for three years.

The practical future of rocket power depends upon a great many factors—not the least of which is the solution of the problems facing the rocket propellant chemist. The ultimate rocket chemicals—whether nuclear, solid, liquid (mono- or bi-propellant), hybrid or the new "exotic" chemicals—must lie within the limited parameters of certain rigid requirements. This discussion deals with some of those basic considerations which influence the chemist's search for improved high energy rocket propellants.

The conventional rocket motor is a heat engine which converts the chemical energy of propellants into heat and the heat into kinetic energy. Propellants react in the combustion chamber of the rocket motor, releasing heat and forming gaseous products, which expand through a nozzle; the expansion converts part of their heat energy into kinetic energy. The gases, now moving at high velocity, are exhausted to the rear, and by the reaction principle they impart a forward force, measured in pounds of thrust, to the motor.

The thrust exerted by a rocket motor is proportional to the exhaust velocity of the reaction products. To produce a high exhaust velocity, the reaction of the propellants must yield a large quantity of heat per unit mass and this heat must be converted into kinetic energy efficiently.

The heat produced is the difference between the heat of formation of the propellants and the heat of formation of the reaction products; so the propellants should have large positive heats of formation and give products with large negative heats of formation. Because of the requirement for large heat of reaction per unit mass (not per mole), only the lightest elements are used in propellants. The most desirable elements are hydrogen, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, magnesium, aluminum and silicon; elements heavier than chlorine are rarely used. The heats of formation of propellants are maximized by incorporating high energy groups such as $-C\equiv C-$, $\succ N-N\prec$ and $-OO-$ into the propellant molecules.

The efficiency of conversion of heat into kinetic energy is inversely proportional to the mean molecular weight of the reaction products. Therefore propellants are designed to give light products, such as H_2, H_2O and CO.

These three requirements, i.e., that the propellants have large positive heats of formation, that the products of reaction have large negative heats of formation, and that the products have low molecular weights, cannot all be optimized simultaneously. A good propellant must have an optimum balance among them. In addition, a propellant should have other desirable properties, such as stability and high density.

The chemistry laboratories at RMI, in support of the applied research, development and production of advanced rocket power systems, are staffed with a team of specialists, highly qualified in many phases of chemistry and chemical engineering. This team is constantly working toward the achievement of this optimum balance of properties in their search for advanced rocket propellants. The well-rounded program of research, analysis and evaluation which contributes to this goal includes such typical activities as mathematical analysis, theoretical chemistry, propellant formulation, combustion chemistry, organic and inorganic synthesis, physical properties and analysis, with special sections devoted to solid and liquid propellant research.

4870

If you desire one or more reprints of Dr. Lippmann's article, or would like to receive additional information about RMI, write to our Information Services Coordinator. Reaction Motors, Inc., 22 Ford Road, Denville, New Jersey.

Power for Progress

RMI

developed by Convair, for the direct measurement of optical distortion encountered in the transparent parts of an airplane.

Flight Control for Jet Transports Uses Inertial Sensors. Victor DeBiasi. *Av. Age*, Dec., 1956, pp. 40, 41, 42–45 ff. Description of the new Sperry system which introduces inertial path damping, inherent parameter control, and integral attitude control.

Progress is Steady Toward Solution of Acute Pilot-Escape Problems. John P. Stapp, R. J. Heymans, and R. M. Stanley. *SAE J.*, Dec., 1956, pp. 44–48.

Compositions for Stripping Rubber Sealants from Integral Fuel Tanks. Appendix I—**Preparation of Stripping Composition for Local Application.** J. H. Sewell. *Gt. Brit., RAE TM Chem.138*, July, 1956. 8 pp. Development of a liquid and a gelled composition to strip rubber sealants from integral fuel tanks.

The Versatile Jet Transport. Richard S. Shevell. (*SAE Natl. Aero. Meeting, Apr., 1956, Paper.*) *Shell Av. News*, Nov., 1956, pp. 15–21. Analysis of the performance of DC-8 jet transport at short, medium, and long ranges as compared with earlier reciprocating-engine types. Some of the changes in the engines and aerodynamic characteristics of aircraft which have contributed to the jet's performance are indicated.

Air Conditioning & Pressurization

A Systematic Study of Air Cycles for Aircraft Cooling Applications. L. R. Stevens, Jr. *ASME Semi-Annual Meeting, Cleveland, June 17–21, 1956, Paper 56-SA-11.* 9 pp. Comparison of thermodynamic performance for various types of air-cycle cooling systems. The most suitable are examined to determine the relative extent of their applicability over a range of aircraft operating conditions.

A Constructional Method for Minimising the Hazard of Catastrophic Failure in a Pressure-Cabin. Appendix I—**Effect of Inter-Stringer Swelling of Pressure-Cabin Skin.** Appendix II—**Window Arrangement Appropriate to the Multiple-Band Scheme of Construction Advocated in This Note.** D. Williams. (*Gt. Brit., RAE TN Struc.156*, Mar., 1955.) *Gt. Brit., ARC CP 286*, 1956. 13 pp. BIS, New York, $0.36.

Germetizatsiia Kabin Reaktivnykh Transportnykh Samoletov. V. Fedorov. *Grazhdanskaia Aviatsiia*, Oct., 1956, pp. 17–19. In Russian. Description of a sealed-type air-conditioning system used in jet transport aircraft.

Controlled Comfort; A Survey of the Problems of Air Conditioning. *Flight*, Nov. 30, 1956, pp. 854–856. Consideration of problems associated with safety, differential pressure, air supply, cooling systems, vapor-cycle cooling, control systems (for flow, humidity, and pressurization), and equipment testing.

High Altitude Breathing Equipment. D. H. Young. *Shell Av. News*, Nov., 1956, pp. 2–6. Historical review of the development of high-altitude breathing equipment.

Landing Gear

High-Energy Aircraft Brake Linings. J. A. Stavrolakis. *Aero. Dig.*, Dec., 1956,

where liquid level is CRITICAL

POSITIVE SWITCHING

The Robertshaw-Fulton Liquid Level Switch . . . an application of atomic age products to instrumentation . . . is simple, positive, and extremely reliable.

In this new instrument, an hermetically-sealed beta source and a beta detector, mounted in a pencil-sized probe, are separated by a small cavity. When no liquid is present, beta particles traverse the cavity, producing a measurable radiation level at the detector. When liquid enters the cavity, beta particles are absorbed by the liquid, thus reducing the radiation level. This change is sensed by the detector and converted to an electrical signal which is then amplified to actuate a relay. The instrument thus provides a reliable, positive, liquid-level indication that is highly insensitive to extreme environmental conditions.

This new Liquid Level Switch is typical of advances being made by the men of the Aeronautical Division of Robertshaw-Fulton Controls Company. Solving your particular problem in reliable instrumentation is our business. We welcome your inquiry.

PRODUCTS FOR PROGRESS
BY THE MEN OF RF AERONAUTICAL

Robertshaw-Fulton
CONTROLS COMPANY
aeronautical division
Santa Ana Freeway at Euclid Avenue • Anaheim, California

MINIATURE OXYGEN REGULATORS • AIRCRAFT VALVES • PNEUMATIC PRESSURE REGULATORS • PRECISION CRYSTAL OVENS

Outstanding Facilities for the Research and Development of Specialized Control Devices

pp. 24, 26, 28. Discussion of linings with classification of the materials used and review of the physical and design requirements, test procedure, and lining compositions.

Silicone Shoes for Brakes. A. P. Bettick. *Prod. Eng.*, Dec., 1956, pp. 172, 173. Design and molding details of an insulator for the inner mechanisms of a brake with a sintered metal lining.

Operation & Performance

Some Performance Problems Associated with the Mach 2 Fighter. J. Morris. (*CAI Annual Gen. Meeting, Montreal, May 4, 1956.*) *Can. Aero. J.*, Dec., 1956, pp. 358–363. Consideration of the choice of configuration with emphasis on the influence of drag due to lift and of trim drag on the choice of wing plan form and type of longitudinal control.

Transport Pilot's Viewpoint; The Pioneering Twins. R. E. Gillman. *The Aeroplane*, Dec. 7, 1956, pp. 849–852. Discussion of the performance and handling qualities of Scottish Aviation Pioneer and Twin Pioneer.

An Energy Approach to Climb Performance Estimation of a Turbo-Jet Transport Aircraft. Appendix I—**Effect on the Slope of the Curve of Climb Weight Against Energy Height of a Change in (a) Climb Weight and (b) Temperature.** Appendix II—**Illustrative Example.** Ramchandra B. Tamboli. *Aero. Quart.*, Nov., 1956, pp. 315–336.

Assessment of the Aircraft for Its Part in a Defence System. R. P. Dickinson. (*NATO AGARD 8th Flight Test Panel, Rome, Feb. 20–25, 1956.*) *NATO AGARD Rep. 32*, Feb., 1956. 8 pp. Discussion of the relative importance of 18 aspects of behavior of an interceptor fighter aircraft in relation to the task of forming an overall appreciation of the aircraft.

Airports

Prestressed Concrete Runways: History, Practice and Theory. I. Alan James Harris. *Airports & Air Transp.*, Nov.-Dec., 1956, pp. 109–111. Discussion of tests on trial slabs and analysis of the resistance mechanism of a prestressed concrete runway. The difficulties of stressing a full-scale runway are examined, and two basic types of runway are defined.

Measurements of Runway Roughness of Four Commercial Airports. Dexter M. Potter. *U.S., NACA RM L56I26*, Jan. 7, 1957. 86 pp.

Geoelektrische Untersuchungen an Flugplätzen. Volker Fritsch. *ZFW*, Nov., 1956, pp. 355–362. In German. Discussion of the possible applications of geoelectric probing for the examination of runways.

Aviation Medicine

Human Tolerance to Prolonged Acceleration. George D. Zuidema, Sanford I. Cohen, Albert J. Silverman, and Mitchell B. Riley. *J. Av. Med.*, Dec., 1956, pp. 469–481.

Comparison of Human Tolerance to Accelerations of Slow and Rapid Onset. Robert Edelberg, James P. Henry, John A. Maciolek, Edwin W. Salzman, and George D. Zuidema. *J. Av. Med.*, Dec., 1956, pp. 482–489. 14 refs.

The Anthropometry of Working Positions. I—A Preliminary Study. H. T. E. Hertzberg, Irvin Emanuel, and Milton Alexander. *USAF WADC TR 54-520 [AD 39439]*, Aug., 1956. 12 pp. 22 refs. Measurements taken on 40 adult males to ascertain new body-size data for various representative working positions. The positions include standing, kneeling, crawling, and prone positions.

Directional Control of Accelerative Forces in Centrifuge by System of Gimbals. Richard J. Crosbie. *J. Av. Med.*, Dec., 1956, pp. 505–511.

Computers

Principles of Programming. J. B. Ward. (*AIEE Fall Gen. Meeting, Chicago, Oct. 1–5, 1956, Paper CP 56-967.*) *Elec. Eng.*, Dec., 1956, pp. 1,078–1,083. Description of a hypothetical sample computer having a limited-order code, with some examples of simple programing, in order to demonstrate general programing principles and some aspects of the type of thinking required for using computers of this kind.

The Representation of Constraints by Means of an Electronic Differential Analyzer. Donald T. Greenwood. *IRE Trans., EC Ser.*, Sept., 1956, pp. 111–113. Description of a method which permits representation of constrained systems in such a way that all coordinates are available for the application of arbitrary forces or displacements. An example is used to illustrate the procedure.

Massnahmen zur Vereinfachung von Rechenplänen bei elektronischen Rechenanlagen. Heinz Schecher. *ZAMM*, Sept.-Oct., 1956, pp. 377–395. 13 refs. In German. Description of an electronic computer; development of methods for the automatic substitution of addresses without special substitution orders; and application of these methods with respect to different types of program structure.

O Raschete Predelov i Shkal Nekotorykh Mnogopredel'nykh Izmeritel'nykh i Schetno-Reshaiushchikh Ustroistv. L. Ia. Miziuk and V. G. Zubov. *Izmeritel'naia Tekhnika*, Sept.-Oct., 1956, pp. 30–34. In Russian. Determination of the range of some multifarious measuring and calculating devices.

Comparing Analog and Digital Computers for Solving Design Problems. D. B. Breedon. *Mach. Des.*, Dec. 13, 1956, pp. 140–142, 144.

Proposals for a Fast, Accurate Voltage Analogue to Digital Converter. Appendix I—**The Error Detector.** Appendix II—**The Reversible Binary Computer.** Appendix III—**An Assessment of the Accuracy and Speed of Response to be Expected from the Analogue to Digital Converter.** Appendix IV—**An Improved Precision Switch.** W. G. Hughes. *Gt. Brit., RAE TN G.W.425*, Aug., 1956. 21 pp.

Digital Time and Sequence Control. Martin L. Klein, Frank K. Williams, and Harry C. Morgan. *Instruments & Automation*, Dec., 1956, pp. 2,403–2,407. Description of the operation of four binary-wired switches which permit simple trunking of a matrix line.

Logical Design of the Digital Computer for the SAGE System. M. M. Astrahan, B. Housman, J. F. Jacobs, R. P. Mayer, and W. H. Thomas. *IBM J. Res. & Devel.*, Jan., 1957, pp. 76–83.

Logic Circuits for a Transistor Digital Computer. G. W. Booth and T. P. Bothwell. *IRE Trans., EC Ser.*, Sept., 1956, pp. 132–138. Description of a group of circuits which fulfill the requirements of speed, low dissipation, size, and weight for air-borne applications.

Education & Training

Construction of a Proficiency Examination for Maintenance Personnel on a New Weapon System. Donald N. Buckner. *USAF PTRC TN 56-105 [AD 098880]*, Aug., 1956. 17 pp. Investigation to determine the feasibility of constructing job-knowledge examinations quite early in the procurement period of a new weapons system in order to facilitate early training of personnel.

Development of a Portable Radar Simulator. Tirey K. Vickers. *U.S., CAA TDR 289 (OTS, PB 111847*, $0.50), Sept., 1956. 9 pp. Development of a portable training device for the basic training of air traffic controllers in radar-vectoring and aircraft-spacing procedures.

Electronics

New Developments in Electronics; Increased Weapon Systems Effectiveness Through Electronics. Gordon T. Gould, Jr. *Am. Ordnance Assoc., 38th Annual Meeting, New York, Dec. 5, 1956, Paper.* 4 pp. Discussion of the need for rapid improvement in the miniaturization, reliability, and maintainability of electronic weapons systems for aircraft application.

New Developments in Electronics; A Pattern for Growth in the Military Electronics Field. Daniel E. Noble. *Am. Ordnance Assoc., 38th Annual Meeting, New York, Dec. 5, 1956, Paper.* 4 pp.

The Phenomenon of Electroluminescence and Its Application in the Electronics Industry. D. W. G. Ballentyne. *Marconi Rev.*, 4th Quarter, 1956, pp. 160–175. 24 refs.

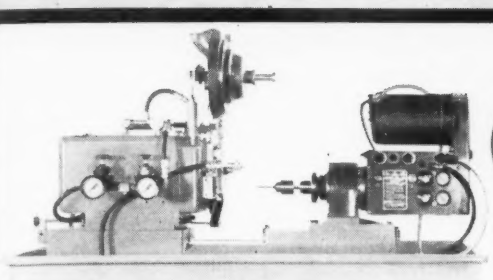
Amplifiers

Wide Band Amplifier Design. J. Kason. *Elec. Eng.*, Jan., 1957, pp. 39–41.

Resistance-Capacitance Tuned Amplifiers Using Negative Feedback. D. J. O'Connor. *Electronic Eng.*, Dec., 1956, pp. 536–539. Comparison of the transfer function of an LC-tuned amplifier with that obtained for a feedback amplifier using particular types of RC feedback networks, and development of a design procedure for circuits having predicted performance.

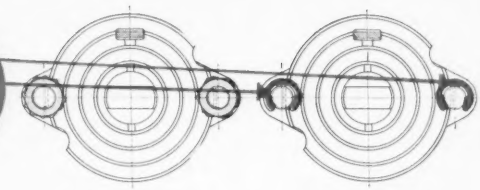
Temperature Stability of Transistor Amplifiers. G. Stuart-Monteith. *Electronic Eng.*, Dec., 1956, pp. 544–547. Theoretical investigation of the most general form of d.c. amplifier circuit and proposal of a "figure of merit" in terms of which the current and voltage stability factors and the voltage gain can be expressed. Analysis is extended to the stability of a multistage d.c. amplifier.

Waldes Truarc Retaining Rings Eliminate Machining and Parts—Cut Assembly Time on Drill and Tapper



Beco Model 410 Drill and Tapper

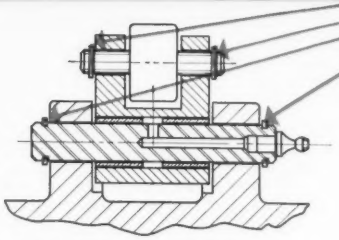
The Batchelder Engineering Co., Inc., Springfield, Vermont uses 4 different sizes of 2 different type Waldes Truarc rings in their new BECO Model 410 Automatic Drill and Tapper. Truarc rings speed assembly, reduce machining, improve design.



ALTERNATE DESIGN TRUARC DESIGN

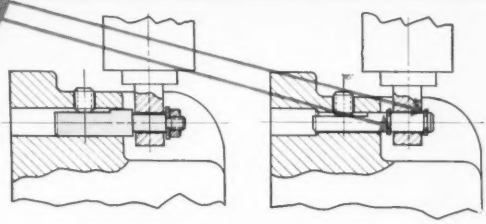
Clamp Cylinder Rod Stop Assembly

Truarc "E" Rings (Series 5133) replace stop nuts in the Clamp Cylinder assembly. They eliminate need for threading 2 rods ...the danger of cross-threading nuts...and costly rejects. Truarc Rings cut assembly time and cost.



Bell Crank Pivot Assembly

Truarc Rings (Series 5100) in Bell Crank Pivot assembly permit grease hole not possible with cotter pin fastener. Use of nuts would have increased machining and assembly costs considerably.



ALTERNATE DESIGN TRUARC DESIGN

Hopper Cylinder Anchor Pin Assembly

2 Truarc Rings (Series 5100) secure and position end of vertical air cylinder. Rings eliminate extra cost of machining 3-diameter pin, threading and undercutting...plus nut and washer. Assembly is quick and sure.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N.Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name .....
Title .....
Company .....
Business Address .....
City ..... *Zone* ..... *State* AE039

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

Half-Wave Magnetic Amplifier Behaviour. J. Baranowski. *Gt. Brit., RAE TN El.119*, May, 1956. 38 pp.

Silicon Diode Chopper Stabilizes D-C Amplifier. Lawrence Fleming. *Electronics*, Jan. 1, 1957, pp. 178, 179. Description of a basic chopper and of a practical amplifier, its phase detector and differential bias. Advantages of high-back-resistance silicone diodes include stability of 100 microvolts per hour and input impedance 100 times greater than that achievable with germanium crystals.

Thermistors Compensate Transistor Amplifiers. A. J. Wheeler. *Electronics*, Jan. 1, 1957, pp. 169–174. Description of typical compensating circuits using thermistors, and presentation of equations for calculating component values, of restrictions on the use of two types of thermistor materials, and of a design technique for approximating to the desired linear decrease in bias with increase in ambient temperature.

Antennas

Radio Aerial Problems in Aircraft. H. J. Draper. *J. SLAE*, Nov., 1956, pp. 10–13. Discussion of the aerodynamic, structural, and radiation characteristics of different types of aircraft antenna.

Mis-Focusing and the Near-Field of Microwave Aerials. D. H. Shinn. *Marconi Rev.*, 4th Quarter, 1956, pp. 141–149. Investigation to determine curves for the theoretical radiation patterns of a mis-focused lens or mirror with a circular boundary, and the near field of the same aerial correctly focused.

Backscattering for Arbitrary Angles of Incidence of a Plane Electromagnetic Wave on a Perfectly Conducting Spheroid with Small Eccentricity. Yasuto Mushiake. *J. Appl. Phys.*, Dec., 1956, pp. 1,549–1,556. 14 refs. Army-sponsored research.

The Back-Scattering from a Circular Loop. Robert G. Kouyoumjian. *Appl. Sci. Res., Sect. B*, No. 3, 1956, pp. 165–179. 13 refs. Theoretical investigation using the variational method to determine the echo area of a perfectly conducting, thin, circular loop. Comparisons are made between the calculated and measured values at the broadside and edge aspects of the loop, and between the echo-area values of the loop and those of the circular plate, the sphere, and the straight wire. The equivalent dipole sources associated with small loop scatterers are also treated.

Circuits & Components

Electronic Circuitry. Charles F. Kezer and Milton H. Aronson. *Instruments & Automation*, Dec., 1956, pp. 2,410, 2,411. Description of four basic circuits in electronic design. These include a capacitor-regulated power supply, two gas diode memory circuits, and a driver amplifier.

Reliability Starts with Circuit Design. James H. Muncy. *Av. Age*, Jan., 1957, pp. 84–89 ff. Discussion of preventive measures in circuit design to improve electronic component reliability.

Application Techniques Leading to Reliable Circuit Performance. John J. Hofler. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 74–76. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

Mathematical Tools for Reliable Design. E. E. Brewer. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 77–84. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

Free Oscillations in Simple Distributed Circuits. A. B. Hillan. *Wireless Engr.*, Dec., 1956, pp. 279–290. Calculation of wave forms which occur when a progressive wave in a transmission line impinges on a terminating circuit. The method of calculation is used to determine the wave forms occurring in certain simple distributed circuits when in free oscillation.

Design of a Reliable Flip-Flop. H. W. Boyd. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 35–40. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

The Relationship of Physical Applications of Fourier Transforms in Various Fields of Wave Theory and Circuitry. E. Folke Bolinder. *Acta Polytechnica*, No. 2 (189), 1956. 22 pp. 30 refs. Application of Fourier transform pairs to the theory of waves and circuitry. The cases of diffraction, reflection, and coupling of waves, the deflection of particles, and the scanning problem are examined.

Application of Low-Mu Triodes to Series Regulators. Sherwin Rubin. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 48–52. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

Keyed Phase Sensitive Demodulator. O. Berger. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 31–34. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

A New Approach in R-F Front-End Design. Bernard B. Bycer. *Tele-Tech*, Jan., 1957, pp. 82–84, 132–134 ff. Description of the theory, design, and operation of a tunable r.f. head which incorporates permeability tuning and the use of a 6021 triode as a reactance modulator at 206 mc.

Operational Bridge Gages High Capacitance. R. L. Konigsberg. *Electronics*, Jan. 1, 1957, pp. 175–177. Description of a low-frequency bridge which uses high-gain d.c. chopper-stabilized operational amplifiers in shunt with two passive ratio arms and is capable of accurately evaluating integrating-network capacitors for missile control systems.

Communications

Special Issue: Single Sideband. *Proc. IRE*, Dec., 1956, pp. 1,663–1,873. 213 refs. Partial Contents: An Introduction to Single-Sideband Communications, J. F. Honey and D. K. Weaver, Jr. Synthesizer Stabilized Single-Sideband Systems, B. Fisk and C. L. Spencer. Frequency Control Techniques for Single Sideband, R. L. Craiglow and E. L. Martin. Synchronous Communications, John P. Costas. The Phase-Shift Method of Single-Sideband Signal Generation, Donald E. Norgaard. The Phase-Shift Method of Single-Sideband Signal Reception, Donald E. Norgaard. Linear Power Amplifier Design, Warren B. Bruene. Distortion Reducing Means for Single-Sideband Transmitters, Warren B. Bruene. Automatic Tuning Techniques for Single-Sideband Equipment, Vincent R. DeLong. Linearity Testing Techniques for Sideband Equipment, P. J. Icenbice, Jr., and H. E. Fellhauer. Conversion of Airborne HF Receiver-Transmitter from Double Sideband to Single Sideband, Harris A. Robinson. The Problems of Transition to Single-Sideband Techniques in Aeronautical Communications, John F. Honey. SSB Performance as a Function of Carrier Strength, William L. Firestone. Design of a High Power Single-Sideband VHF Communications System, John W. Smith. Single-Sideband Techniques in UHF Long-Range Communications, W. E. Morrow, Jr., C. L. Mack, Jr., B. E. Nichols, and J. Leonhard.

Radio Relay Equipment Employing Pulse-Modulated Microwaves. H. Paul. *Brown Boveri Rev.*, Sept., 1956, pp. 344–351. Review of three types of radio relay equipment, with discussion of the method of operation and the design of the transmitter and receiver.

Measures to Increase the Reliability of Radio Relay Links. I. Wigdorovits. *Brown Boveri Rev.*, Sept., 1956, pp. 361–368. Discussion of four types of change-over devices used in radio relay work in the case of a brief stoppage in the main unit.

Construction Techniques

Designing Airborne Equipment for Vibration. Salvatore P. Mercurio, Jr., and Michael Belby. *Electronics*, Jan. 1, 1957, pp. 166–168. Discussion of techniques of chassis design, component placement, and testing methods to help achieve maximum reliability in electronic equipment for aircraft and missile applications.

Designing for the New Environments. W. R. Richardson. *Av. Age*, Jan., 1957, pp. 72, 73–77 ff. Discussion of electrical problems encountered in flight and due to the high altitude, high temperature, shock, vibration, and acoustical noise.

Reliability of Electronic Apparatus; Some Statistics and Their Implications. D. A. Bell. *Wireless World*, Dec., 1956, pp. 591–594.

Resin-Embedment Process Control for Optimum Electronic Package Design. Charles A. Harper. *Elec. Mfg.*, Jan., 1957, pp. 85–89, 246, 248 ff. Methods to use epoxy- or polyester-based resins for the embedment, encapsulation, and potting of electronic packages.

Parts Will Have to Stand More Heat, Nuclear Radiation. John P. Hanna. *Av. Age*, Jan., 1957, pp. 78–83 ff. Discussion of radiation as it affects electronic design.

Cooling

Heat Control in Electronic Equipment. I. E. N. Shaw. *Elec. Eng.*, Jan. 1957, pp. 13–23. Study of natural methods of cooling compact equipment with a view to improving thermal stability and reducing component failure rate due to overheating.

Dielectrics

New Glass Dielectrics. W. E. Hauth, Jr., and A. L. Pugh, Jr. *Elec. Mfg.*, Jan.,

ROHR'S BIG ROLE IN THE COMMERCIAL JET AGE

Because of far greater design, engineering and production know-how in the field of power packages ***Rohr has been chosen to build complete, ready-to-install power packages for America's great, new jet-powered airliners*** – the Boeing 707, the Convair 880, the Lockheed Electra Propjet (all shown above).

Actually, current programs at Rohr include the production of power packages and jet pods for fifteen leading commercial and military planes – plus many other major aircraft components including stabilizers, elevators, fuselage sections, pneumatic system components, high strength weldments, brazed stainless steel honeycomb sandwich panel structures and metal bonded panels.

When it comes to design, engineering, and production know-how in aircraft components, come to Rohr.

World's largest producer of ready-to-install Pow-R-Pax for airplanes

Excellent career openings now for engineers and tooling technicians.

ROHR
AIRCRAFT CORPORATION
CHULA VISTA, CALIFORNIA

Also plants in Riverside, California • Winder, Georgia • Auburn, Washington

Honeywell Aero's MIG (Miniature Integrating Gyroscope). Weight: 0.5 lbs. Size: 1.75 inches in diameter. Performance: equal to gyroscopes 3 times larger. Just one of more than 70 new Honeywell Aero products put into production during the past year.

RESEARCH, DESIGN AND DEVELOPMENT ENGINEERS

WHAT WILL YOU THINK OF NEXT?

If it's in aeronautical controls, there are exciting opportunities for you at Honeywell. Honeywell Aero's outstanding development programs now in progress offer exceptional opportunities for research, design and development engineers in the following fields:

INERTIAL GUIDANCE • DIGITAL COMPUTERS • FLIGHT CONTROL SYSTEMS • LIQUID MEASUREMENT SYSTEMS • VERTICAL AND RATE GYROS • STABILIZED PLATFORMS • INLET AREA CONTROLS • JET ENGINE CONTROLS.

At Honeywell, you'll work with your own design team which includes a technician, a model maker, an evaluation engineer and a draftsman. You'll guide your own project from start to finish, get quick recognition and advancement.

You start with a first rate salary and because Honeywell rewards talent as well as experience, increases are based primarily on merit. There's a liberal program of extra benefits, too.

Positions are now open in Minneapolis, Minnesota, city of lakes and parks, which offers exceptional cultural, recreational and educational advantages for your whole family.

Production Engineers. There are also outstanding opportunities for production engineers in the above fields.

WRITE TODAY! If you are interested in a career at Honeywell, call collect or send your résumé to Bruce D. Wood, Technical Director, Dept. TA4A Aeronautical Division, 1433 Stinson Boulevard, N. E., Minneapolis 13, Minnesota.

MINNEAPOLIS **Honeywell** Aeronautical Division

1957, pp. 100–103. Applications of titania glasses to high-temperature capacitors and insulators, glass-to-metal seals, and sintered glass shapes.

Dielectric Properties of Several Solid Solutions Which Contain Barium Titanate. N. S. Novosil'tsev and A. L. Khodakov. *Soviet Physics-Tech. Phys.*, No. 2, 1956, pp. 306–318. 14 refs. Translation.

Reflectionless Transmission Through Dielectrics and Scattering Potentials. I. Kay and H. E. Moses. *J. Appl. Phys.*, Dec., 1956, pp. 1,503–1,508. USAF-supported derivation of a complete solution for the problem of constructing a plane stratified dielectric medium having the property that, at a fixed frequency and polarization, a plane wave at any angle of incidence will be transmitted without reflection by the medium. Results are applicable to the problem of finding perfectly matched, nonuniform transmission lines.

Electronic Tubes

Electron Tube Misapplication When Uncovered Through Field Surveillance. Mahlon H. Norton. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 14–24. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

Field Trial Technique as a Tool to Improve Reliability and Life in Electron Tubes. Louis F. Moose. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 8–13. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

Receiving Tube Reliability Studies. George H. Gage, Jr. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 96–105. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

Designing for Reliability Through the Proper Application of Tubes. C. M. Ryerson. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 64–73. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

Series String Applications of Electron Tubes (Commercial and Military). R. G. Rauth. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 41–47. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

Reliability in Dissimilar Section Tubes. R. W. Slinkman. *RETMA Symposium on Reliable Applications of Electron Tubes Proc., Penn. U., May 21, 22, 1956*, pp. 92–95. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

Defective Tubes—Manufacturer or User Responsibility. Robert D. Wilson. *RETMA Symposium on Reliable Applications of Electron Tubes, Proc., Penn. U., May 21, 22, 1956*, pp. 25–30. (New York, Engineering Pub., 1956, $5.00. 105 pp.)

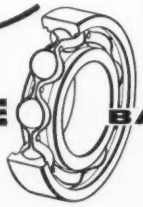
Magnetic Devices

Basic Considerations in Foil Transformer Production. W. Brackmann, R. Levinsohn, and D. McCarthy. *Elec. Mfg.*, Jan., 1957, pp. 94–99. Discussion of development work to mechanize small transformer production by using wafer

FACTS

about

NEW DEPARTURE BALL BEARINGS



AIRCRAFT TURBINE BALL BEARINGS... ENGINEERED FOR PLUS PERFORMANCE

Dependability of performance! That's the keynote of New Departure's specialized ball bearings for fast, high-flying jets!

Leading production jet engines contain the evidence! They use split inner ring turbine mainshaft bearings (size range below)—an out-ahead development of New Departure's Aircraft Bearing Research Program. This advance in bearings combines simplified maintenance and assembly with high load-carrying ability at high speeds and temperatures.

New Departure also manufactures aircraft ball bearings for refrigeration turbines, alternator-drive turbines, high-temperature fuel pumps, turbine-driven air compressors, and small gas turbines—all backed by New Departure's research and precision manufacturing.

Use the coupon below for further information about New Departure ball bearings for today's jet aircraft . . . and what New Departure has in development for tomorrow.

MEDIUM and LARGE TURBINE BEARINGS

Basic Bearing No.	NOMINAL DIMENSIONS		
	Bore	O.D.	Width
LL34	6.6929	9.0551	1.102
LL36	7.0866	10.2362	1.614*
LL44	8.6614	12.5984	1.929*
L22	4.3307	7.0866	1.280*
L24	4.7244	7.4803	1.280*
L26	5.1181	7.8740	1.280*
L28	5.5118	8.6614	1.574*
L30	5.9055	8.5060	1.235*
L32	6.2992	9.4488	1.338
L34	6.6929	10.6299	1.815*
207	1.3780	2.8346	.669
209	1.7717	3.3465	.938*
212	2.3622	4.3307	.866
213	2.5591	4.7244	.905
214	2.7559	5.1181	1.023
215	2.9528	5.1181	1.181*
216	3.1496	5.5118	1.023
219	3.7402	6.6929	1.259
220	3.9353	7.0886	1.385*
222	4.3307	7.8740	1.771*
224	4.7244	8.4646	1.850*
228	5.5118	9.4488	2.007*
232	6.2992	10.1992	1.660
307	1.3780	3.1496	.826
315	2.9528	6.2992	1.456

*Puller groove, inner ring or both rings

NEW DEPARTURE • GENERAL MOTORS CORPORATION
BRISTOL, CONNECTICUT

ATT: DEPARTMENT O

Please forward me a copy of your latest folder on aircraft turbine ball bearings.

Name_____ Title_____

Company_____

Street Address_____

City_____ Zone_____ State_____

SEE "WIDE WIDE WORLD" SUNDAYS—NBC-TV

BALL BEARINGS MAKE GOOD PRODUCTS BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

coils spirally wound from aluminum or copper foil.

Nekotorye Voprosy Rascheta i Konstruirovaniia Elektromagnitnykh Priborov s Z-Obraznym Podvizhnym Serdechnikom. V. V. Smeliakov. *Izmeritel'naia Tekhnika*, Sept.–Oct., 1956, pp. 25–29. In Russian. Analysis of different aspects of the calculation and design of electromagnetic devices having a Z-shaped movable core.

Measurements & Testing

Microwave Measuring Devices. H. H. Klinger. *Electronic Eng.*, Dec., 1956, pp. 524–532. 37 refs. Review of the principles and characteristics of microwave measuring devices for radio link systems, with emphasis on devices required for developing, testing, installing, and monitoring link systems.

Noise & Interference

Some Statistical Properties of Signal Plus Narrow Band Noise Integrated Over a Finite Time Interval. L. C. Maximon and J. P. Ruina. *J. Appl. Phys.*, Dec., 1956, pp. 1,442–1,448. ONR-supported derivation of the variance of narrow band noise plus c.w. signal after detection and integration over a finite time interval, and solution of the problem for Ideal, Gaussian, and High Q Single Tuned filters with square and linear detection (the latter for large predetection signal-to-noise ratio) as well as for a model which considers the envelope of narrow band noise plus signal as a function which is constant for intervals of duration equal to the reciprocal of the noise band width and statistically independent in different intervals.

Response of Peak Voltmeters to Random Noise. Arnold P. G. Peterson. *Gen. Radio Exp.*, Dec., 1956, pp. 3–8.

Oscillators & Signal Generators

How to Design Colpitts Crystal Oscillators. H. E. Gruen. *Electronics*, Jan. 1, 1957, pp. 146–153. Description of a design method which makes use of performance curves of output and crystal drive level to predict oscillator output voltage to better than 25 per cent and the performance of circuit having a wide range of parameter values.

Analytical Approaches to Local Oscillator Stabilization. W. Y. Pan and D. J. Carlson. *RCA Rev.*, Dec., 1956, pp. 534–552. Analysis of the behavior of local oscillator tubes and associated circuit elements under complex conditions of heat flow to achieve stability up to and beyond 1,000 mc.

Power Supplies

Power Supply Regulator Design. H. R. Hyder. *Tele-Tech*, Jan., 1957, pp. 62, 63, 147–148 ff. Evaluation of basic regulator circuit designs in terms of ripple, output impedance, and transient response.

Wafer-Type Millimeter Wave Rectifiers. W. M. Sharpless. *Bell System Tech. J.*, Nov., 1956, pp. 1,385–1,402. ONR-supported description of a silicon point-contact rectifier and holder designed primarily for use as the first detector in millimeter wave receivers.

Power Generation and Distribution at Air Defense Computing Centers. J. J. Gano. *Elec. Eng.*, Dec., 1956, pp. 1,098–1,102. USAF-Army-Navy-supported description of a diesel-power generation and distribution system in which continuity is achieved by the installation of reserve generating capacity, by duplexing the power-distribution system, and by placing emphasis on equipment reliability.

Radar

Film Reader Measures Recorded Radar Echoes. Allan Shapiro. *Electronics*, Jan. 1, 1957, pp. 154–165.

Applying the Doppler Effect to Direction Finder Design. Joseph A. Fantoni and Richard C. Benoit, Jr. *Tele-Tech*, Jan., 1957, pp. 75–77, 147. Description of a method to determine and plot transmission direction by scanning in sequence a circular array of fixed antennas, used to simulate the effect of a moving antenna, and comparing the phase-angle differences between the sampled voltages.

Measuring Radome Tracking Error. John B. Damonte and Albert F. Gaetano. *Tele-Tech*, Jan., 1957, pp. 66, 128–130 ff. Description of equipment designed to measure the degree of tracking error caused by radome distortion of the returned signal.

Resistors

Resistor Evaluation for Critical Applications. Robert Davie, Joseph P. Gehegan, and A. A. Andriolo. *Elec. Mfg.*, Jan., 1957, pp. 74–77. Analysis of drifts in initial resistance value as used in estimating long-term stability. An approach to specifying and derating resistors for specific applications is presented.

High Value Resistors and Their Measurement. G. France. *Elec. Eng.*, Jan., 1957, pp. 24–30. 13 refs. Discussion of methods to determine the value of resistors, and description of an instrument having measuring capacity up to 10^{14} ohms.

Semiconductors

1957 Semiconductor Diode Specifications. *Tele-Tech*, Jan., 1957, pp. 95, 97–99 ff. A list of 881 germanium and silicon diodes grouped by types and manufacturers.

An Analysis of Diffusion in Semiconductors. S. Zaromb. *IBM J. Res. & Devel.*, Jan., 1957, pp. 57–61. 12 refs. Study based on Onsager's theory which shows that interaction between acceptors, donors, electrons, and holes may lead to complicated diffusion equations. In particular, appreciable covalent compound formation is likely to occur between some substitutional donors and acceptors.

The Problem of the Effect of a Strong Field in Semiconductors. Iu. K. Pozhela. *Soviet Physics - Tech. Phys.*, No. 2, 1956, pp. 273–276. Translation.

Recombination of Electrons and Holes When Various Types of Traps are Present. S. G. Kalashnikov. *Soviet Physics - Tech. Phys.*, No. 2, 1956, pp. 237–247. Translation. Analysis of the problem of the recombination of nonequilibrium charge carriers in a semiconductor in the presence of recombination centers of various types.

Clarification of First-Order Semiconduction Effects Through Use of Electrochemical Potentials. J. A. Swanson. *IBM J. Res. & Devel.*, Jan., 1957, pp. 39–43. Simplification of the first-order treatment of conduction effects in semiconductors. Poisson's equation is shown to be ignorable in the first-order treatment of steady-state effects. Application is given to the Hall effect and to the characterization of probes.

Electron Microscope Investigation of the Sub-Electrode Layer of a Selenium Rectifier with a Cadmium Electrode. V. A. Dorin and D. N. Nasledov. *Soviet Physics - Tech. Phys.*, No. 2, 1956, pp. 279–286. 12 refs. Translation. Investigation to determine the thickness of the diffusion interlayers of cadmium, selenium, and sulphur compounds which affect the electrical properties of selenium rectifiers.

I—Isothermal Time Variations of the Electrical Conductivity of Polycrystalline Selenium After Abrupt Temperature Variations. II—Isothermal Time Variations of the Concentration of Current Carriers and of the Electrical Conductivity of Polycrystalline Selenium After Abrupt Temperature Variations. P. T. Kozyrev. *Soviet Physics - Tech. Phys.*, No. 2, 1956, pp. 252–267. 10 refs. Translation.

The Diffusion of Impurities in Germanium. B. I. Bolmaks. *Soviet Physics - Tech. Phys.*, No. 2, 1956, pp. 443–457. 48 refs. Translation. Review of experimental information on the diffusion of impurities in germanium. The data show that there is a close connection between diffusion and solubility and also between diffusion, solubility of the impurities, and electrical properties of germanium.

Emission Capability of an Abrupt p-n-Transition and Its Effect Upon the Conductivity of a Semiconductor. K. B. Tolpygo. *Soviet Physics - Tech. Phys.*, No. 2, 1956, pp. 287–305. 13 refs. Translation.

The Great Transistor Chaos. *Wireless World*, Dec., 1956, pp. 601–605. Discussion of transistor symbols in an effort to standardize circuit forms and sets of parameters.

Transistor Super-Regenerative Circuits; Working Conditions for Optimum Performance. D. F. Page. *Wireless World*, Dec., 1956, pp. 606–609.

The Junction Transistor as a Computing Element. I. E. Wolfendale, L. P. Morgan and W. L. Stephenson. *Elec. Eng.*, Jan., 1957, pp. 2–7. Evaluation of the possibilities and limitations of junction transistors used in computer circuits.

Die galvanomagnetischen Effekte in Halbleitern. *VDI Zeitschrift*, Nov. 21, 1956, pp. 1,853, 1,854. In German. Analysis of galvanomagnetic effects in semiconductors.

Transmission Lines

Electromagnetic Transmission Characteristics of a Lattice of Infinitely Long Conducting Cylinders. Zohrab A. Kaprielian. *J. Appl. Phys.*, Dec., 1956, pp. 1,491–1,502. 18 refs. ONR-supported study.

Helix Waveguide. S. P. Morgan and J. A. Young. *Bell System Tech. J.*, Nov., 1956, pp. 1,347–1,384. 14 refs. Investigation of the properties of a helix wave guide using the sheath helix model. Approximate formulas are given for the propagation constants of the lossy modes.

The Application of Ferroxcube in Unidirectional Waveguides and Its Bearing

Here's another

New DC Motor
by EEMCO

Type D-932, designed and produced as an alternator drive for a 400 cycle supply on a new missile.

EEMCO Type D-932 DC motor operates continuously at a regulated speed of 12,000 rpm, plus or minus ½ of 1%, under the following varying conditions:

From .5 HP to 2.6 HP with a terminal voltage of 27.5 DC, plus or minus 1.5 volts.

The constant speed of 12,000 rpm is maintained by a frequency regulator that supplies the control field of the double-field stator of the motor. Type D-932 has an internal spline, and can be supplied with or without a radio noise filter, which is shown in the illustration.

Type D-932 is another in the series of new AC and DC motors being custom designed and produced currently by **EEMCO** for the latest missiles and supersonic jet aircraft. In fact, there is an **EEMCO** motor or actuator system on the majority of such new weapons now in production or projected for use by our Armed Forces.

This, we believe, is an expression of confidence in **EEMCO**, which for the past 15 years has specialized exclusively in the design and production of motors and actuators, both linear and rotary, for prime and subcontractors in the aircraft industry.

SPECIFICATIONS FOR TYPE D-932

Type: DC motor for alternator drive for 400 cycle supply on a missile.
Speed: Continuous at 12,000 rpm, plus or minus ½ of 1%.
Speed Control: By frequency regulator supplying control field.
Load: From .5 HP minimum to 2.6 HP maximum.
Terminal Voltage: 27.5 DC plus or minus 1½ volts.
Weight: With radio noise filter—13.9 lbs. Without same—12.4 lbs.

EEMCO ELECTRICAL ENGINEERING & MANUFACTURING CORP.

4612 West Jefferson Boulevard, Los Angeles 16, California • Telephone REpublic 3-0151

DESIGNERS AND PRODUCERS OF MOTORS, LINEAR AND ROTARY ACTUATORS . . . EXCLUSIVELY!

3-547

on the Principle of Reciprocity. H. G. Beljers. *Philips Tech. Rev.*, Nov., 1956, pp. 158–166. 13 refs.

Surface Finish and Attenuation of Aluminium Waveguides. J. Allison and F. A. Benson. *Elec. Eng.*, Jan., 1957, pp. 36–38. 17 refs.

Wave Propagation

Theory of Wave Motion of an Electron Plasma. A. I. Akhiezer and R. V. Polovin. (*Zhurnal Experimental'noi i Teoreticheskoi Fisiki*, May, 1956, pp. 915–928.) *Soviet Physics - JETP*, Dec. 1956, pp. 696–705. Translation. Analysis of the nonlinear wave motions of an electron plasma for arbitrary electron velocities in order to establish a correspondence between the wave motion of the plasma and the motion of a nonrelativistic particle in a certain potential field, to determine the variation of the frequency of longitudinal vibrations on the velocity amplitude, and to calculate the frequencies of the nonlinear transverse vibrations of the plasma and of the vibrations close to them. A number of relations are established for the complicated longitudinal transverse plasma oscillations.

Electromagnetic Surface Waves Above a "Comb" (Corrugated) Structure. L. A. Vainshtein. *Soviet Physics - Tech. Phys.*, No. 2, 1956, pp. 379–390. Translation. Development of a theory for the propagation of electromagnetic surface waves along a two-dimensional comb structure. The theory is based upon the functional equation method which is used in the rigorous theory of radiation from the open end of a wave guide.

Långdistansförbindelser med Spridningssignaler. Gösta Carlson. *Tek. Tidskrift*, Nov. 6, 1956, pp. 947–953. 16 refs. In Swedish. Study of the phenomena of wave propagation and long-distance communication with circulation signals.

Equipment

Données Générales en Matière d'Étude et de Production des Équipements Aéronautiques. R. Maurice de Lorris. *Tech. et Sci. Aéronautiques*, No. 5, 1956, pp. 197–203. In French. Survey of air-borne equipment including navigational aids, recording instruments, simulators, engine instruments, safety equipment, air-conditioning and deicing installations, and hydraulic and pneumatic equipment.

Electric

An Investigation Into the Cause of Boiling Batteries in Meteor Aircraft and the Recommended Remedial Action. W. R. Hinton, R. H. Forrest, and R. L. A. McKenzie. *Gt. Brit. RAE TN El.126*, Sept., 1956. 15 pp. Recommendations to prevent boiling in Type H batteries by a simple modification of the voltage-regulator circuit.

Hydraulic & Pneumatic

New Trends in Aircraft Hydraulic Components and Systems. F. Moncher, K. Postel, and E. Brown. *Vickers, Inc., Paper.* Discussion of hydraulic systems with emphasis on increasing the reliability of present pumps, motors, and valves; improving their performance; and integrating several components in one common housing.

The Hydraulic System of the Canadair CL 28 Maritime Reconnaissance Aircraft. W. W. McKenzie. *Canadair Ltd., Paper.* 19 pp. Description of the hydraulic system of the reconnaissance version of the Bristol Britannia. The system operates the main and nose landing gear, main wheel brakes, nose-wheel steering, control-surface locking, and the bomb-bay doors. Modifications to the basic Britannia system are noted.

Hydraulic and Pneumatic Problems in High Performance Aircraft. Ralph E. Middleton. *Appl. Hydraulics*, Dec., 1956, pp. 98, 101. Discussion of the effects of system temperatures ranging from 400° to 600°F. on the selection of materials, design of components, and system design.

Design and Development of a 1/2 H.P. Pneumatic Motor. L. A. McGee. *Australia, ARL Mech. Eng. Note 190*, Sept., 1954. 23 pp. Description of a machine-tool cutting-head motor whose design was developed from that of a vane-type motor capable of twice the efficiency normally associated with such motors. Includes method for accurate correlation of the theoretical design process with experimental data.

Transient Effects of Supply and Connecting Conduits in Hydraulic Control Systems. S. S. L. Chang. *J. Franklin Inst.*, Dec., 1956, pp. 437–452. Derivation of basic equations for both laminar and turbulent transient flow of a slightly compressible fluid in a metal tubing.

Flight Operating Problems

Landing Technique & Safety. Randall H. Carpenter. *Flight Safety Found., Bul. 56-110*, Nov. 30, 1956. 6 pp. Summary of relevant data on the significance of such factors as wet surfaces and incorrect approach speeds, the increase in landing distances, landing roll, the effect of wing lift, speed and friction, the use of wing flaps, and pilot familiarization.

Comments on "Analysis of a Rolling Pull-Out Maneuver." W. J. G. Pinsker. *J. Aero. Sci.*, Jan., 1957, pp. 68, 69. Discussion of the Oakes-Holliday method for calculating fin loads in rolling pull-out maneuvers. An analysis is made using principal inertia axes instead of stability axes, and neglecting gravity components. The full pitching-moment equation and angle of attack are treated as variables.

A Flight Investigation of the Wake Behind a Meteor Aircraft, with Some Theoretical Analysis. D. R. Andrews. (*Gt. Brit., RAE TN Aero.2283*, Dec., 1954.) *Gt. Brit., ARC CP 282*, 1956. 34 pp. BIS, New York, $0.90. Theoretical and experimental results which show that the rolling moment imposed on a tracking vehicle constitutes the most severe disturbance from the trailing vortices, and that in some circumstances this rolling moment can be sufficiently large to overpower the aileron control of the tracking aircraft.

Rain Erosion—Barrier to High Speed Flight; CAL Develops Special Test Equipment and Neoprene Coating in Erosion Studies. Norman E. Wahl. *Res. Trends* (*Cornell Aero. Lab.*), Fall, 1956, pp. 5–7.

Turbulence Encountered by Viking Aircraft Over Europe. J. R. Heath-Smith. *Gt. Brit., RAE TN Struc.204*, July, 1956. 16 pp. Acceleration tests which show the number of gust decreases from sea level to 8,000 ft. There is some evidence below 5,000 ft. that turbulence is greatest in spring and least in autumn. Average gust frequencies during climb and descent were twice those during cruise below 8,000 ft., and this is attributed to the pilot's discretion in the choice of cruising altitude.

Flight Testing

Installing Flight-Test Instrumentation in Production Aircraft. J. E. Smith. *Aero Dig.*, Dec., 1956, pp. 20–23. Discussion of wing-tip fuel tanks which provide an economic package for instruments and equipment for in-flight tests and permit shortening of ground time because equipment can be modified in the laboratory and then installed in the unitized tank.

High Speed Test Flying. Charles E. Yeager. *J. RAeS*, Dec., 1956, pp. 785–793; Discussion, pp. 793–798. Discussion, from the pilot's viewpoint, of flight-test experience with early research aircraft designed to operate in the transonic and supersonic regions and at high altitudes.

Fuels & Lubricants

Contribution à l'Étude de la Combustion des Bases Pyridiques. Jean Ploquin. *France, Min. de l'Air NT 62*, 1956. 21 pp. 16 refs. SDIT, 2 Av. Porte-d'Issy, Paris 15, Frs. 385. In French. Experimental study of the slow combustion of pyridine, performed at temperatures between 400° and 600°C., with a primary carbon monoxide and carbon anhydride formation, and with a discharge of molecular nitrogen. It is pointed out that the pyridine homologue has higher combustive potentialities than the pyridine alone; the latter can produce a nonexplosive effect.

Operational Safety Aspects of Jet Fuels. A. R. Ogston. *Esso Air World*, Sept.-Oct., 1956, pp. 40–45. Discussion of the characteristics of kerosene and JP-4 fuels.

Properties, Uses, and Development of Hydraulic Fluids. F. H. Langenfeld. *Vickers Air Transport Hydraulic Conf., Detroit, Nov. 13, 14, 1956, Paper.* Discussion of the development of an aircraft hydraulic fluid in terms of 15 requirements for safety and serviceability.

Ignition Delays and Fluid Properties of Several Fuels and Nitric Acid Oxidants in Temperature Range from 70° to −105° F. Riley O. Miller. *U.S., NACA TN 3884*, Dec., 1956. 32 pp. 17 refs. Experimental investigation of a number of fuel-oxidant combinations, selected as worthy of further study from about 90 combinations tested in a modified open-cup apparatus at −40°F., to determine the freezing temperatures of acids as well as the viscosities of several fuels at moderate and low temperatures.

Storage of Free Radicals at Low Temperature. *The Engr.*, Dec. 7, 1956, pp. 828, 829. Development of a technique

"HOT STUFF" coming through...

A vital product need just ahead on the horizon, lies in the field of INFRARED*. For detection of any potential aggressor, Hot stuff* comes through! IR* has numerous significant advantages: target size is not critical... a passive seeker, it never divulges its source or location... will outperform radar of comparable dimensions. IR can't be jammed... when detecting, it can't be detected. LMEE... pioneering these advantages... has the research and production facilities to make all this a protective reality today. Its Advanced Electronics Center at Ithaca, New York, has an INFRARED Projects Group staffed by recognized authorities on IR development. INFRARED by LMEE... with its broad applications to Airborne Weapons Control Systems... is another LMEE contribution to new uses of Defense Electronics. For information on IR ... write Section E.

LMEE

Aviation Electronics Products Include:

WEAPONS CONTROL RADAR • SEARCH RADAR • INDICATORS AND DISPLAY • COUNTERMEASURES • NAVIGATION
MISSILE CONTROL • AIRBORNE SONAR • COMMUNICATIONS • FUZES • AUTOMATIC TEST • DATA PROCESSING

Progress Is Our Most Important Product

GENERAL ELECTRIC

LIGHT MILITARY ELECTRONIC EQUIPMENT DEPARTMENT
FRENCH ROAD, UTICA, NEW YORK

One of these days
... you'll be living in
Southern California

If you're happy right where you are—if you like your job, your boss, your neighbor's children, the weather—then this message may be a little premature.

But if you sometimes suspect things could be better, then we'd like to tell you about the Southern California Cooperative Wind Tunnel, and about living in Pasadena.

We don't expect anybody to pull up stakes and move out here tomorrow. But if you're looking for more of the good things in life, both job-wise and otherwise, we think the CWT and Pasadena have a great deal to offer. No resume to send—just mail the coupon below for the CWT story.

CWT

Operated by the California Institute of Technology. Owned by Convair, Douglas, Lockheed, McDonnell and North American.

CWT is concerned with testing, analysing and solving aerodynamic problems involved in the development of high-speed aircraft and guided missiles.

Southern California Cooperative Wind Tunnel

952 South Raymond, Pasadena, California

GENTLEMEN: *Please send me literature about the Wind Tunnel.*

NAME_____

HOME ADDRESS_____

CITY_____ STATE_____

JOB TITLE_____

for capturing and storing large numbers of highly reactive molecular fragments at temperatures near absolute zero.

Ice Formation & Prevention

Experimental Droplet Impingement on Several Two-Dimensional Airfoils with Thickness Ratios of 6 to 16 Percent. Appendix A, B—Determination of Cloud Droplet Size and Liquid-Water Content From Measured Impingement Rates on Bodies. Appendix C—Prediction of Impingement on Swept Airfoil from Results Obtained on Unswept Airfoil. Thomas F. Gelder, William H. Smyers, Jr., and Uwe von Glahn. *U.S., NACA TN 3839*, Dec., 1956. 77 pp. 24 refs.

Direct Solution of the Heat-Balance Equation for Thermal Anti-Icing Systems. Timoleon G. Argyropoulos. *Aero. Eng. Rev.*, Feb., 1957, pp. 60–63. Presentation of a graphical method using monographs to solve the heat-balance equations directly for a heated, wetted surface.

Instruments

Some Principles of Measurement and Control. J. F. Coales. *J. Sci. Instr.*, Dec., 1956, pp. 457–464. Development of a simple theory of linear control systems in which it is shown that the only real difference between measuring and control systems is in the magnitude of the power required at the output. Negative feedback in a closed-loop is shown to be equivalent to the restoring force in an open-loop system.

An Automatic Recording Spectrophotometer. D. C. Brown. *Coll. of Aeronautics, Cranfield, Rep. 111*, Nov., 1956. 25 pp. Description of the design and the photographic and photoelectrical applications of a new type of concave-mirror plane-grating spectrograph.

The Expected Error of a Least-Squares Solution of Location from Direction-Finding Equipment. B. Harkin. *Australian J. Appl. Sci.*, Dec., 1956, pp. 263–272.

Study of Explosive Vapor Detection. Thomas M. Shaw, Frank K. Truby, and Wilbur R. Wood. *USAF WADC TR 56-293 (OTS, PB 121517*, $6.00), June, 1956. 265 pp. 291 refs. Survey of vapor-detection methods and instrumentation to detect rocket-propellant vapors in operational, piloted, rocket-powered aircraft.

High-Performance Instrumentation; Appropriate Equipment for a Mach 2 Fighter—A Pilot's Suggestions. Michael Morss. *Flight*, Nov. 23, 1956, pp. 811–813.

On an Air-Driven Gyro Horizon with Laterally Tilted Axis Which Can Prevent the Occurrence of Turning Errors. Shin'ichiro Takeda. *J. Japan Soc. Aero. Eng.*, Oct., 1956, pp. 5–10.

Novyi Elektricheskii Pribor dlia Zamera Pul'satsii Davleniia. M. A. Markin. *Izmeritel'naia Tekhnika*, Sept.-Oct., 1956, pp. 49–52. In Russian. Design and description of an apparatus for measuring pressure pulse.

Automatic Control

The Logic of Automata. Arthur W. Burks and Hao Wang. *U. Mich. Eng.*

These RECORD HOLDERS Use VICKERS® HYDRAULICS

VERTOL H-21 ARMY HELICOPTER
1199 Mile World's Distance Record
for Helicopters, August 11, 1956

First Non-Stop Transcontinental Helicopter Flight with In-Flight Refueling
August 23 and 24, 1956

SIKORSKY H-34 ARMY HELICOPTER
World's Speed Record for 100, 500 and
1000 Kilometers, July 12, 1956

The two craft shown here use Vickers pumps, motors and valves for a variety of important operations.

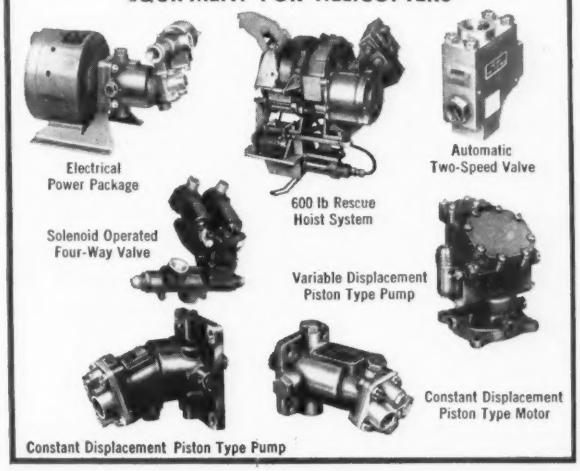
• • • • • •

New and unusual applications for hydraulics are being scheduled into several of the newer helicopter designs. Among these are hydraulic motor operated fuel transfer pumps and hose reels. Vickers Hydraulic Equipment will also be used for taxiing, rotor fold, starting, rescue hoist systems and auxiliary electrical power generation.

• • • • • •

Ask our nearest application engineer to tell you about them, or write for bulletin 7504.

REPRESENTATIVE VICKERS HYDRAULIC EQUIPMENT FOR HELICOPTERS


Electrical Power Package
600 lb Rescue Hoist System
Automatic Two-Speed Valve
Solenoid Operated Four-Way Valve
Variable Displacement Piston Type Pump
Constant Displacement Piston Type Motor
Constant Displacement Piston Type Pump

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1414 • Detroit 32, Michigan

EL SEGUNDO DIVISION • Engineering, Sales and Service
2160 E. Imperial Highway, El Segundo, California

District Aircraft Sales and Service Offices:
Albertson, Long Island, N. Y., 882 Willis Ave. • Arlington, Texas, P. O. Box 213
Seattle 4, Washington, 623 8th Ave. South • Washington 5, D.C., 624-7 Wyatt Bldg.
Additional Service facilities at: Miami Springs, Florida, 641 De Soto Drive
TELEGRAMS: Vickers WUX Detroit • TELETYPE: "ROY" 1149 • CABLE: Videt
OVERSEAS REPRESENTATIVE:
The Sperry Gyroscope Co., Ltd.—Great West Road, Brentford, Middx., England

7637

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Res. Inst. TN 2512-2-F (AFOSR TN 56-539) [AD 110358], Dec., 1956. 57 pp. 17 refs. Development of systems and techniques of mathematical logic to analyze the structure and behavior of automata. Classes of automata are distinguished as fixed and growing, deterministic, and probabilistic.

Integrated Control Systems for Aircraft. R. Hadekel. *Appl. Hydraulics*, Dec., 1956, pp. 95, 96, 98.

On the Use of the Harmonic Linearization Method in the Automatic Control Theory. E. P. Popov. (*Doklady Akad. Nauk, SSSR*, No. 2, 1956.) *U.S., NACA TM 1406*, Jan., 1957. 6 pp. Translation. Method in which a given nonlinear equation is replaced by a linear one. In establishing the method a small parameter is considered which makes it possible to approximate a solution of the new equation to the given nonlinear equation.

O Chastotnom Metode Opredeleniia Proizvodnykh Perekhodnoi Funktsii. B M. Kagan. *Avtomatika i Telemekhanika*, Nov., 1956, pp. 1,035–1,037. In Russian. Development of a frequency method for determining transient derivatives of stable systems.

Experimental'noe Opredelenie Zhestkosti Rezino-Tkanevykh Membran. V. P. Temnyi. *Avtomatika i Telemekhanika* Nov., 1956, pp. 1,042–1,045. In Russian. Experimental determination of the rigidity of rubber membranes used in different automatic control devices at changing initial load and pressure.

O Primenenii Vychislitel'nykh Ustroistv v Avtomaticheskikh Sistemakh. A. A. Fel'dbaum. *Avtomatika i Telemekhanika*, Nov., 1956, pp. 1,046–1,056. 26 refs. In Russian. Review of the application of computers to automatic control devices taking into account the theory and construction of automatic systems.

O Periodicheskikh Rezhimakh v Releinykh Sistemakh s Vnutrennei Obratnoi Sviaz'iu. N. A. Korolev. *Avtomatika i Telemekhanika*, Nov., 1956, pp. 969–978. In Russian. Analysis of periodic processes in relay systems with inner feedback.

Primenenie Nelineinykh Korretktiruiushchikh Ustroistv v Sistemakh Avtomaticheskogo Regulirovaniia Vtorogo Poriadka. G. M. Ostrovskii. *Avtomatika i Telemekhanika*, Nov., 1956, pp. 979–984. In Russian. Methods of improving control quality of second-order linear servosystems by introducing special nonlinear devices.

Teoriia Upravliaiushchego Ustroistva Tipa "Soplo-Zaslonka", Rabotaiushchego na Masle. A. G. Shashkov. *Avtomatika i Telemekhanika*, Nov., 1956, pp. 1,000–1,019. In Russian. Derivation of the equations of motion for a control device of the "nozzle-flapper" type. The transmitting function of the control device is determined, taking into account the variability of nozzle expenditure.

Black Box Flying Controls; Integrated Systems Reviewed. *Flight*, Nov. 30, 1956, pp. 843, 844, 846. Consideration of the F-104 Starfighter in order to study the state of the flying-control art.

Synthesis of Aircraft Hydraulic Servos. George R. Keller and Elliott R. Buxton. (*SAE Natl. Aero. Meeting, Oct., 1956.*) *Appl. Hydraulics*, Dec., 1956. pp. 90, 92, 95. Abridged. Survey covering synthesis and design; servo configuration, dynamic requirements, specifications, valves, and testing; analytical tools; integration; fluid supply; and actuator design.

Variably Damped Servomechanisms. L. Schieber. *Elec. Eng.*, Dec., 1956, p. 1,103. Description of the equipment, discussion of its advantages, and presentation of a block diagram showing its essential elements.

A Novel Relay Amplifier. J. H. Askew. *Trans. Soc. Inst. Tech.*, Dec., 1956, pp. 133–142; Discussion, pp. 142, 143. Description of an amplifier for servocontrol motors. The control is effected by reversing the polarity of motor armature voltage in a cyclic manner without breaking the main power-supply circuit.

Ob Ustoichivosti Sistem Avtomaticheskogo Regulirovaniia s Odnim Reguliruiushchim Organom. B. S. Razumikhin. *Avtomatika i Telemekhanika*, Nov., 1956, pp. 958–968. In Russian. Development of a method for studying the stability of nonlinear automatic control systems possessing one control unit.

Kriterii Ustoichivoi Raboty Dvukhfaznago Asinkhronnogo Servodvigatelia. E. I. Slepushkin. *Avtomatika i Telemekhanika*, Nov., 1956, pp. 1,020–1,028. 10 refs. In Russian. Analysis of stable operating conditions of two-phase servomotors as units of automatic control and regulation systems. The criteria for stable operation are expressed in terms of generalized parameters, and the analytical results are confirmed by experimental data.

Hydraulic Servo Components. II—Their Effect on System Performance. III. J. M. Nightingale. *Mach. Des.*, Dec. 13, 27, 1956; pp. 133–136; 73–76. 13 refs. Analysis of power drives which consist of a power source, control value and main amplifier, and the servomotor.

Flow Measuring Devices

Some Aspects of the Measurement of Oscillatory Hydraulic Flow Including Nonlinear Effects. Robert S. Wick. *Jet Propulsion*, Dec., 1956, pp. 1,078–1,083. 13 refs. Investigation of oscillatory flow in which a venturi-type flowmeter is simulated by a model capable of analysis under nonsteady flow conditions. Nonlinear effects and the effect of inertia are included in the model chosen.

Raskhodomer dlia Vozdukha s Korrektsiei Pokazanii. G. I. Ratnov. *Izmeritel'naia Tekhnika*, Sept.-Oct., 1956, pp. 57–61. In Russian. Design and description of a device for measurements and presentation of corrected data on flow through nozzles and ducts of the Venturi type.

Temperature Measuring Devices

Theory and Design of a Pneumatic Temperature Probe and Experimental Results Obtained in a High-Temperature Gas Stream. Appendix A, B—**Estimation of Effective Specific-Heat Ratio.** Appendix C—**Cooling Requirements.** Appendix D—**Orders of Magnitude of Possible Errors.** Appendix E—**Sample Calculation for Experimental Probe.** Frederick S. Simmons and George E. Glawe. *U.S., NACA TN 3893*, Jan., 1957. 41 pp. 14 refs.

Pirometry EOP-51M i OP-48M dlia Izmereniia Temperatury do 6000°C. V. E. Finkel'shtein, E. S. Shpigel'man, and V. V. Kandyba. *Izmeritel'naia Tekhnika*, Sept.-Oct., 1956, pp. 52–54. In Russian. Design and description of an apparatus for temperature measurements up to 6,000°C.

Vibration Measuring Devices

Electrodynamic Standards for Vibration Pickups. *U.S., NBS Sum. TR 2076*, Dec., 1956. 13 pp. Army-supported development of a method for standardizing electrodynamic calibrators by determining the relationship between the calibrators' electrical output and the vibratory motion.

Instrumentation Notes for Shock Tests. I—Measurements of Shock and Vibration Under Extreme Environmental Conditions. Arthur C. Diechmiller. **II—How to Select Electromagnetic Vibration Pickups.** A. W. Orlacchio. *Elec. Mfg.*, Jan., 1957, pp. 78–84. Discussion of design features and applications of vibration pickup for high-frequency measurements at high temperature.

Laws & Regulations

Freedom of the Air. Frederick Tymms. *J. Aero. Soc. India*, Aug., 1956, pp. 43–66. 16 refs. Historical review of the international decisions concerning the concepts of air sovereignty and security and the question of the commercial rights of scheduled and nonscheduled air services.

Machine Elements

PLI Washers and the Preloading of Bolts. *Douglas Serv.*, Nov.-Dec., 1956, pp. 8–23. Evaluation of the preload-indicating washer giving the purpose of preloading, characteristics, and applications to Douglas DC-6 and DC-7 transports.

A Balanced-Pressure Sliding Seal for Transfer of Pressurized Air Between Stationary and Rotating Parts. Arthur N. Curren and Reeves P. Cochran. *U.S., NACA RM E56I11*, Jan. 9, 1957. 17 pp.

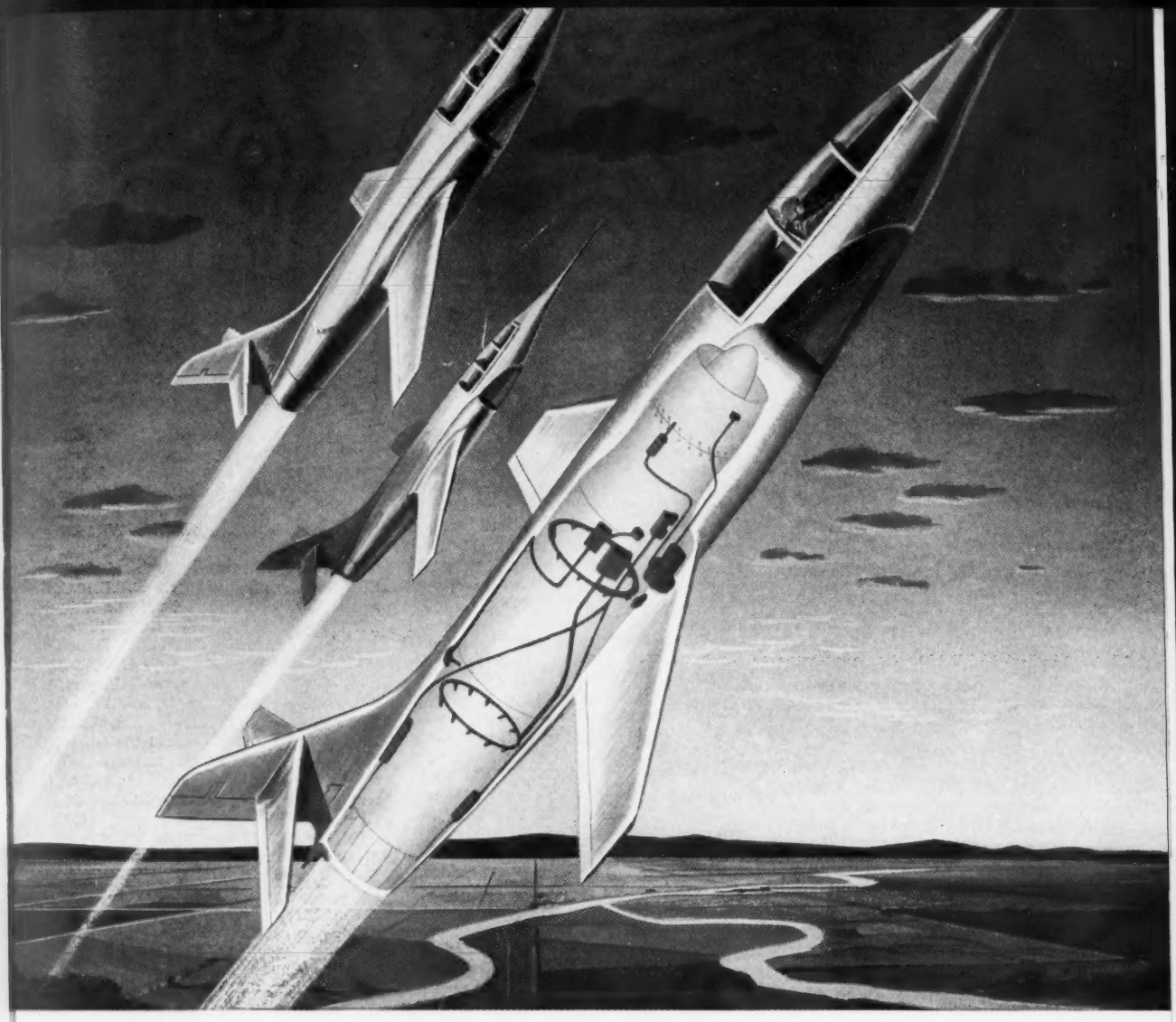
Reducing Trial and Error in Compression Spring Design. J. J. Intintolo. *Prod. Eng.*, Jan., 1957, pp. 206–208. Application of graphical methods to develop a boundary of acceptable spring dimensions based on variables of spring design.

Bearings

Designing Ball Bearings for High Speeds and Temperatures. Heinz Hanau. *Av. Age*, Jan., 1957, pp. 56–61 ff. Discussion of ball bearings for turbines operating at 500–700°F.

The Tapered-Land Thrust Bearing. C. F. Kettleborough. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 581–583. Computations indicating that the maximum load capacity of the tapered-land bearing is 14 per cent greater than that carried by the tilting-pad bearing when side leakage is taken into account.

Performance of 110-Millimeter-Bore M-1 Tool Steel Ball Bearings at High



TOWARD MACH 3

WITH A COMPLETE BENDIX SYSTEM FOR FUEL METERING AND ENGINE CONTROL

When the pilot swings the lever from idle to emergency thrust—or back again—things must happen fast in the big jets.

But not too fast!

For, pouring it on, or cutting back faster than the engine can take it, spells disaster. The penalties are ruinous over-temperatures, compressor stall or flame-out.

When the pilot orders a change in thrust, the Bendix fuel metering and engine control system takes over. Fuel feed is automatically computed and scheduled. Geometric controls such as exhaust nozzle area and inlet vane angles are set. Automatically and instantly, engine response is crowded to the limit—but not beyond!

Matched sets of Bendix components—pressure and temperature sensors, electronic amplifiers, fuel metering units and engine control actuators—work together as a *system*, spanning the length and girth of the engine.

Bendix components, designed and engineered together, invariably give more efficient performance than any arbitrarily assembled system.

And there is the further important advantage of having one source and having that source completely responsible for over-all dependable operation on the plane.

So, when it comes to fuel metering and engine controls, think of a complete and integrated system. Then we suggest you think of Bendix and the Bendix Products Division.

Bendix PRODUCTS DIVISION **South Bend,** IND.

Bendix
AVIATION CORPORATION

Speeds, Loads, and Temperatures. William J. Anderson. *U.S., NACA TN 3892*, Jan., 1957. 38 pp. 13 refs. Experimental investigation with the following ranges of operating variables: DN (product of bearing bore in mm. and shaft speed in r.p.m.), 0.4×10^6 to 1.54×10^6; outer-race mean temperatures to 678°F.; thrust load, 1,000 to 7,000 lbs.; radial load, 1,000 to 4,900 lbs.; oil flow, 6 to 18 lbs./min.; and oil inlet temperatures, 100° to 300°F.

A New Oil-Less Bearing Material. John D. Shaw and Walter V. Knopp. *Prod. Eng.*, Jan., 1957, pp. 203–205. Discussion of the properties, advantages, and limitations of full-density graphite-metal powder combinations which are self-lubricating even at extreme temperatures and pressures.

Gears & Cams

Tooth Gearing and Research. Appendix I—**Graphs of Profile Error; the Effects of Hob Form on Gear Tooth Profiles.** Appendix II—**Formulae Governing Relationship Between Hob Form and the Transverse Profile Errors of the Gear Hobbed.** Appendix III—**Gear Loading Formulae.** S. A. Couling. *The Engr.*, Dec. 28, 1956, pp. 915–918.

Limitations on Cam Pressure Angles. Harold A. Rothbart. *Prod. Eng.*, Jan., 1957, pp. 193–195. Method for selection of the maximum pressure angle based on distribution of forces in the cam follower. Four types of cam followers are analyzed: overhead, system with a secondary follower, flat-faced follower, and oscillating roller.

Maintenance

Continuous Airworthiness. K. E. Marsden. *Can. Aero. J.*, Dec., 1956, pp. 364, 365. Description of the new Canadian Department of Transport system which permits the issuance of a Certificate of Airworthiness valid for new aircraft until they are sold, provided that the approved continuous maintenance and inspection system is followed.

Prévision Statistique des Avaries et Calcul des Volants et Rechanges. R. Descamps. *Docaéro*, Nov., 1956, pp. 23–26. In French. Application of statistical methods for determining life expectancy and breakdown, continuation of function, and structural and material fatigue.

Dockanlagen für Verkehrsflugzeuge bei der Deutschen Lufthansa. J. Doetsch. *Luftfahrttechnik*, Oct. 15, 1956, pp. 192–197. In German. Description of special installations for overhaul and maintenance used by Lufthansa.

Materials

Selecting Materials for Electrical Contacts. Victor G. Mooradian. *Materials & Methods*, Sept., 1956, pp. 121–140. Includes evaluation of operating conditions and of life and reliability requirements, selection of the basic contact material, and determination of the contact design.

Ceramics & Ceramals

Tailor Made Precision Ceramic Parts. W. F. Janssen. *Materials & Methods*, Sept., 1956, pp. 107–109. Method of producing ceramics with desired properties or dimensions held to a high degree of accuracy by close control of formulation and processing variables.

Effect of Ceramic Coatings on Creep of Alloys. *U.S., NBS Sum. TR 2065*, Dec., 1956. 6 pp.

Corrosion & Protective Coatings

Fretting Corrosion. R. B. Waterhouse. *IME Proc.*, No. 59, 1955, pp. 1,157–1,164; Communications, pp. 1,165–1,171; Author's reply, pp. 1,171, 1,172. 58 refs. Investigation of fretting corrosion defined as the particular damage which occurs when two surfaces in contact experience slight periodic relative movement. Three possible processes involved are: (1) mechanical abrasion by grinding or welding, (2) abrasion by hard particles of oxide, and (3) continual mechanical rupture of otherwise protective oxide films.

Protecting Molybdenum at High Temperatures. Julius J. Harwood. *Materials & Methods*, Dec., 1956, pp. 84–89. 23 refs. Evaluation of coatings to protect molybdenum from high-temperature oxidation. Developments show that electrodeposited chromium and nickel layers can protect molybdenum up to 2,000°F., that sprayed metal coatings are applicable up to 2,400°F., and that ceramic and molybdenum disilicide coatings hold promise for still higher temperatures.

Porosity Detection in Plated Coatings. *U.S., NBS Sum. TR 2057*, Dec., 1956. 4 pp. Description of a nondestructive method for determining both the size and position of the pores. The procedure involves photographing an electroplated specimen exposed to radiation.

Low Viscosity Cellulose Acetate Butyrate: New Protective Lacquer for Aluminum. Robert J. Fabian. *Materials & Methods*, Sept., 1956, pp. 104, 105.

Protective Coatings for Titanium. *Tech. News Bul.*, Dec., 1956, pp. 174, 175. Development of an electrodeposited hard adherent protective coating. The procedure involves forming a titanium fluoride film on the metal surface, electroplating with chromium, and heat-treating the plated specimen at 800°C.

Metals & Alloys

A Dictionary of Metallurgy. L—UL–Vi. A. D. Merriman and J. S. Bowden. *Metal Treatment*, Dec., 1956, pp. 487–494.

Effect of Electron Irradiation on Young's Modulus. H. Dieckamp and A. Sosin. *J. Appl. Phys.*, Dec., 1956, pp. 1,416–1,418. Experimental investigation to measure Young's modulus and internal friction on high-purity copper following electron bombardment, and analyses to interpret the data obtained in terms of dislocation pinning as a shortening in effective length.

Mechanism of Fatigue. W. A. Wood. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 1–19. 18 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

New Developments in Metallurgy; Opening Address for Metallurgy Seminar. Robert Franklin Mehl. *Am. Ordnance Assoc., 38th Annual Meeting, New York, Dec. 5, 1956, Paper.* 9 pp. Discussion and evaluation of the characteristics and applications of high-temperature alloys, titanium and its alloys, and forging steels.

New Developments in Metallurgy; Notes for Metallurgy Seminar. John B. Johnson. *Am. Ordnance Assoc., 38th Annual Meeting, New York, Dec. 5, 1956, Paper.* 3 pp. Discussion covering the properties, applications, and development of super alloys, titanium, and high-tensile steels.

Fatigue Tests on Notched and Unnotched Sheet Specimens of 2024-T3 and 7075-T6 Aluminum Alloys and of SAE 4130 Steel with Special Consideration of the Life Range from 2 to 10,000 Cycles. Walter Illg. *U.S., NACA TN 3866*, Dec., 1956. 40 pp.

The Compression Strength of Steel Sheet Materials to Spec., D.T.D.124A and D.T.D.138A. A. G. Cole. *Gt. Brit., RAE TN Struc.208*, Aug., 1956. 16 pp.

Magnetic Materials Push Back Design "Stops." William Arrott. (*AIEE 2nd Natl. Conf. on Magnetism and Magnetic Materials, Boston, Oct. 16–19, 1956.*) *Elec. Mfg.*, Jan., 1957, pp. 62–73, 298–314 ff. Review of selected papers on the following subjects: permanent magnets, soft magnetic materials, ferrites and thin films, test methods and apparatus, and new devices and components.

Super-High Strength Constructional Steels. H. P. Tardif. *Steel Processing*, Dec., 1956, pp. 702–704, 709, 710. 25 refs. Discussion giving the composition and mechanical properties of new steel developments with a tensile range from 200,000 to 300,000 psi, and yet having reasonable impact properties.

Performance of Steel Under Repeated Loading. M. Hempel. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 83–103. 31 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Aeronautical Development in Australia. L. P. Coombes. *The Engr.*, Nov. 23, 1956, pp. 741, 742. (Also in *Flight*, Nov. 23, 1956, pp. 822, 823.) Abridged. Discussion of research on chromium alloys, their stability during combustion, and their influence on flame-out.

How to Use Creep Data in Design. Ward F. Simmons. *Materials & Methods*, Nov., 1956, pp. 120–123. Discussion of the significance of creep data, and application of these data to both long-life and short-life equipment.

Metals & Alloys, Nonferrous

Experiments Relating to the Origin of Fatigue Cracks. N. Thompson. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 43–61. (New York, Academic Press Inc., 1956, $12. 456 pp.)

How 7 Nonferrous Metals Perform at Low Temperatures. T. Gela, W. J. Lepkowski, and H. M. Gade. *Materials & Methods*, Sept., 1956, pp. 116–120. Test results giving tensile, fatigue, and impact properties at −100°F. for beryllium copper, phosphor bronze, silver solder,

NEW TOUGH

S-T-R-E-T-C-H-E-D PLASTICS

BY SWEDLOW TO PROVIDE

VISIBILITY

IN LOCKHEED'S NEW PROPJET ELECTRA

All passenger windows in Lockheed's new Electra will be Swedlow's new Stretched Acrylic plastic material. It provides excellent visibility... and its extra toughness assures an extra factor of safety.

Naturally, we feel that Lockheed made a good choice. Other factors influencing Lockheed's decision were:

Highest quality of workmanship and service • Reliable delivery records • Technical expertness in formulating and fabricating plastics.

For complete information on the new Swedlow "Stretched Acrylics" and other Swedlow plastic products, we invite your inquiry on your company letterhead.

Ultra-modern Sky Lounge on the Lockheed Electra. High visibility provided by Swedlow "Stretched Acrylic" windows.

New Lockheed Electra—For short and medium range commercial transport. Payload 21,638 lbs. Cruising speed 405 m.p.h. Range 2700 miles, without touching reserve fuel. Can land at full load on 62% of nation's airports. 2400 ft. per min. climb. Operates to 30,000 ft. altitude. Wingspan 99 ft. Fuselage 104 ft. 6½ in. Tail height 32 ft. 1 in. Passenger capacity 66 to 91. Four 3750 H.P. Model 501 D-13 propjet engines. Full production in 1958.

SWEDLOW "STRETCHED ACRYLICS" HAVE AMAZING PROPERTIES

Stretching of acrylics on a production basis has been a Swedlow-sponsored development over the last few years. The process involves the molecular rearrangement of acrylic sheeting by appreciable mechanical stretching.

Results: *Excellent Visibility* | *Higher Resistance to Stress Crazing*

Greatly Improved Toughness | *Reduced Notch Sensitivity*

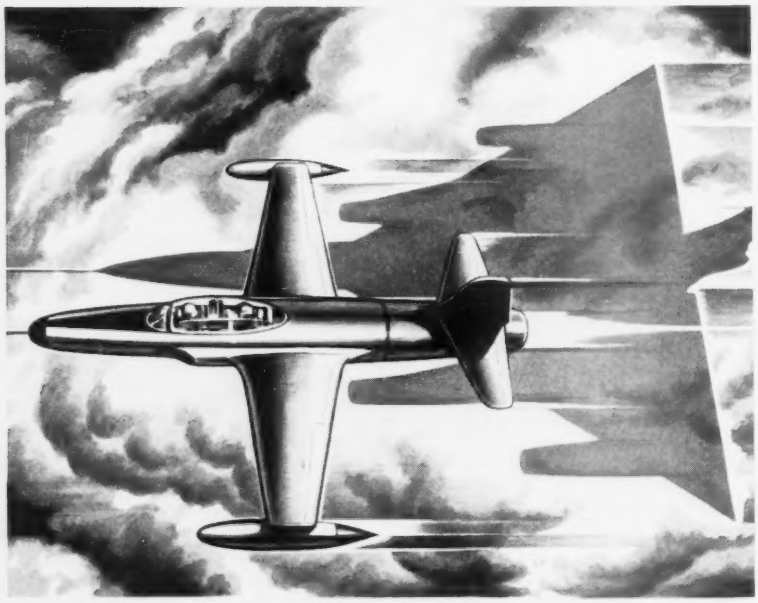
Do YOU have an application requiring these features. If, so we'd like to serve you. Write TODAY!

Swedlow

PLASTICS CO.

Los Angeles, California • Youngstown, Ohio

Please Refer to Dept. 13



THE F-94 CASTS A

SUPERSONIC SHADOW

AT CORNELL AERONAUTICAL LABORATORY

Months before the Convair B-58 supersonic bomber took to the air, its handling characteristics had been successfully simulated by C.A.L. on a totally different airplane.

Our study of the predicted performance of the new bomber's proposed control system and configuration was accomplished with a modified F-94 fighter carrying highly-specialized hydraulic, mechanical and electronic components. The stick forces and motions of the B-58, as well as its stability characteristics, were reproduced by this automatic control system, one of the products of C.A.L.'s continuing long-term effort in artificial stability and control research.

This project is typical of the 160 varied research projects currently active at C.A.L. — stimulating, technically challenging, and professionally significant. Our research program is unusually broad in scope, encompassing such areas as Aerodynamics, Propulsion, Aeroelasticity, Wind Tunnel Research, Flight Research, Aircraft Design and Missile Systems. This broad program, coupled with our policy of assigning each staff member in accordance with his individual abilities and interests, makes it possible for us to offer outstanding employment opportunities to capable and imaginative men.

CORNELL AERONAUTICAL LABORATORY, INC. *OF CORNELL UNIVERSITY*

WRITE FOR FREE REPORT
The story behind Cornell Aeronautical Laboratory and its contributions to aeronautical progress is vividly told in a 68-page report, "A Decade of Research." Whether you are interested in C.A.L. as a place to work or as a place to watch, you will find "A Decade of Research" both useful and pertinent. Mail the coupon now for your free copy.

W. A. Diefenbach
CORNELL AERONAUTICAL LABORATORY, INC.
Buffalo 21, New York

Please send me "A Decade of Research."

Name _____

Street _____

City _____ Zone _____ State _____

☐ Please include employment information

molybdenum, tungsten, tantalum, and nilvar.

Beryllium as an Aircraft Structural Material. George A. Hoffman. *Aero. Eng. Rev.*, Feb., 1957, pp. 50–55, 82. Review of a study on beryllium, including structural evaluation and economic considerations.

Lattice Strains in 70 - 30 Brass. J. H. Auld and R. I. Garrod. *Australia, ARL Rep. Met.7*, Oct., 1954. 28 pp. 20 refs. Investigation to assess the influence of intergranular stresses, macroscopic stresses and deformation faults on the residual lattice strains observed on polycrystalline specimens of 70-30 brass after plastic extension.

Molybdenum Alloys; When to Use Them. R. R. Freeman and J. Z. Briggs. *Materials & Methods*, Nov., 1956, pp. 114–117. Comparison of properties of molybdenum alloys, and methods of selection for particular high-temperature application.

Flexural Fatigue Tests on 5L3 Aluminium Alloy Sheet. J. M. Finney. *Australia, ARL S&M Note 228*, May, 1956. 9 pp.

The Mechanism of Fatigue in Aluminum and Aluminum Alloys. P. J. E. Forsyth. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 20–42. 25 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

On the Effects Preceding Fatigue Failure of High-Strength Aluminum Alloys. R. F. Hanstock. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 62–82. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Static Strength and Fatigue Properties of Unnotched Circular 75S-T Specimens Subjected to Repeated Tensile Loading. Waloddi Weibull. *Sweden, Flygtekniska Försöksanstalten, FFA Medd. 68*, June, 1956. 29 pp. Statistical analysis of data from a series of 24 static tensile tests and 270 fatigue tests by determination of the median S-N curve, the scatter and the distribution function of the fatigue strength as well as the P-S-N equation.

The Creep Deflexion of Magnesium Alloy Struts. A. E. Johnson, V. D. Mathur, and J. Henderson. *Aircraft Eng.*, Dec., 1956, pp. 419–425. Investigation to determine the possibility of predicting the creep deflection of magnesium alloy struts from tensile creep data.

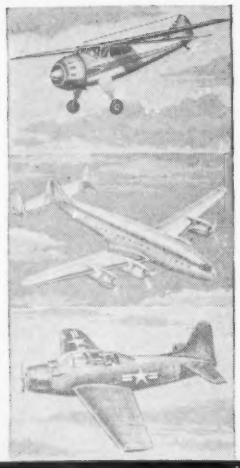
Ti-22. Metal of the Future. M. G. Dobrolyubskaya. (*Sci. & Life*, No. 11, 1955, pp. 17–19.) *Canada, DSI Transl. 15*, Feb., 1956. 3 pp. Discussion of titanium properties and production methods in the U.S.S.R.

Industrial Potential of Titanium. Ronald L. Carmichael. *Battelle Tech. Rev.*, Dec., 1956, pp. 9–13.

Stretch-Forming Titanium; Properties, Heat-Treatment, Manipulation at Room Temperature and at Elevated Temperatures. S. R. Carpenter. *Aircraft Prod.*, Dec., 1956, pp. 496–501. 13 refs.

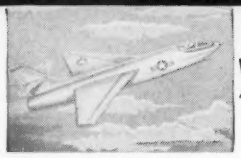
Nonmetallic Materials

Materials and Techniques for Structural Bonding with Metal-to-Metal Adhesives. Sydney A. Hanks. *Mach. Des.*, Dec. 27, 1956, pp. 78–85. Discussion of the factors involved in selection of ad-



WITTEK
Aviation
STAINLESS STEEL
HOSE CLAMPS
Meet Current Military Specifications

Dependability in Hose Clamps for over a Quarter of a Century



6244

Write for Catalog

WITTEK Manufacturing Co.
4305-37 W. 24th Place
Chicago 23, Illinois

Aviation HOSE CLAMPS

A COMPLETE MEDIA PACKAGE
FOR YOUR
Aviation Marketing Program

AERONAUTICAL ENGINEERING REVIEW

For your monthly advertising message to the aircraft industry's engineering and design personnel—the men who influence buying.

1957
NEW MEDIA
DATA
BROCHURE
Available!

6 pages of FACTS on your market and REVIEW.

Write for free copy TODAY!

AERONAUTICAL ENGINEERING CATALOG

Prefiles and distributes your aircraft products catalog to aviation's buyers and specifiers.

7,000 copies are distributed annually to aircraft engineers, designers, technicians and purchasing agents in all leading aircraft, engine and parts companies, Government aviation departments and leading air lines.

Write for your free copy of 4-page Folder giving full details.

OFFICIAL PUBLICATIONS
INSTITUTE OF THE AERONAUTICAL SCIENCES
2 East 64th Street New York 21, N.Y.

BIW
BOSTON INSULATED WIRE & CABLE CO.

LOOK TO B.I.W. FOR
Leadership

COLD!! LOW TEMPERATURE CABLES DESIGNED FOR HIGH ALTITUDE AIRCRAFT & MISSILE APPLICATIONS AND FOR STORAGE AND USE IN THE FROZEN ARCTIC.

BIW has met the challenge with our TYPE SOX Cables which have withstood months of flight testing and years of satisfactory service in these unusual severe flight conditions.

Tabulated below is a series of SOX Multi-conductor Aircraft Cables available for extreme low temperature applications:

BIW Type	Gauge Size	No. of Conductors	O.D. ±.015"
SOX2-20	#20	2	.290"
SOX3-20	20	3	.300
SOX4-20	20	4	.310
SOX7-20	20	7	.365
SOX9-20	20	9	.415
SOX2-18	18	2	.350
SOX3-18	18	3	.365
SOX4-18	18	4	.395
SOX7-18	18	7	.390
SOX9-18	18	9	.450
SOX2-16	16	2	.380
SOX2-14	14	2	.450

Picture a plane anchored to the frozen ice of an airport in the Arctic or Alaska—temperature 50° below zero! On the nose of the propeller is a cable extending from the hub to the electrically heated de-icer boot cemented to the propeller. This cable is in the form of a loop which, upon the starting of the engine, rotates with the propeller; and is subjected to vibration and centrifugal force under which any normal cable would crack and rupture in five minutes.

BIW #149 series cables withstand the terrific vibration, and extreme cold of this severe service for hundreds of hours.

The next time you fly a commercial plane take a second look at the **BIW** cable on the propellers, forming a loop and molded on to the de-icer boot.

Consider another **BIW** Cable—a multi-conductor cable, trailing behind an aircraft for 150 feet, at the end of which is mounted a camera, electrically operated from the cockpit—flexing and whipping in the wind under the severe cold of high altitude. **BIW** Cable #781 has withstood the tests and service, and is now accepted for production as a satisfactory cable for meeting this unusual requirement.

For other unusual applications to meet your requirements, write to:

BOSTON INSULATED WIRE & CABLE CO.
70 BAY STREET • BOSTON 25, MASS.

52856
U.S. AIR FORCE

USAF F-104 Starfighter, the "Missile With a Man in It."

IF, AS YOU READ THIS, YOU SHOULD HEAR A LOCKHEED F–104 STARFIGHTER FLYING OVERHEAD, DON'T BOTHER TO LOOK FOR IT. THIS WORLD'S FASTEST JET WILL BE OUT OF SIGHT BEFORE YOU CAN FINISH READING THESE FEW WORDS.

— — — — — — —

LOCKHEED *means leadership*

LOCKHEED CALIFORNIA DIVISION: *Burbank, Bakersfield, Maywood and Palmdale, California*

JET FIGHTERS • JET TRAINERS • LUXURY AIRLINERS • PROPJET TRANSPORTS • AIRBORNE EARLY-WARNING AIRCRAFT • ANTI-SUBMARINE PATROL PLANES •

hesives, types of adhesives available to the designer, and some important factors in structural bonding.

Shear Strength at 75°F to 500°F of Fourteen Adhesives Used to Bond a Glass-Fabric-Reinforced Phenolic Resin Laminate to Steel. Appendix A—**Description of Adhesives Used in Investigation.** Appendix B—**Fabrication Techniques.** John R. Davidson. *U.S., NACA TN 3901*, Dec., 1956. 21 pp.

The Seam Strength of a Nylon Fabric. J. E. Swallow and M. Fox. *Gt. Brit. RAE TN Chem.1285*, Sept., 1956. 15 pp. 10 refs.

Stronger Reinforced Plastics. James W. Case. *Materials & Methods*, Sept., 1956, pp. 114, 115. Development of nonwoven parallel glass mat, finished and bonded with an epoxy-type solvent solution, which can double flexural strength and triple the elastic limit of reinforced polyester laminates.

Elevated Temperature Properties of Reinforced Plastics. I. Katz and J. Godberg. *Materials & Methods*, Nov., 1956, pp. 130–133. 13 refs. Data on glass-reinforced phenolic, polyester, and silicone laminates at temperatures ranging from 300° to 1,000°F.

Vapor Pressure of Plastic Materials. Niels Jensen. *J. Appl. Phys.*, Dec., 1956, pp. 1,460–1,462. OSR-supported description of a measuring method and derivation of an empirical relation for the equivalent nitrogen vapor pressure of polymeric materials over a range of temperatures.

Improved Gasketing Material. *Materials & Methods*, Sept., 1956, p. 149. Discussion of properties of Teflon-impregnated felt used as a gasketing material.

New Thermoplastic for Tough Service Conditions. *Materials & Methods*, Nov., 1956, pp. 110–112. Evaluation of chlorinated polyether resin which possesses good heat resistance, low water absorption, high dimensional stability, and good dielectric qualities.

An Equation for Tension Creep of Three Unfilled Thermoplastics. W. N. Findley and Gautam Khosla. *SPE J.*, Dec., 1956, pp. 20–25. 13 refs. Results of creep tests on three plastics from which a creep equation for thermoplastics is derived.

Rubber in Aviation. E. A. Smith. *Aeronautics*, Dec., 1956, pp. 47–49. Discussion of the structure, properties, and uses of rubber in aircraft design.

Behaviour of Rubber in Compression Under Dynamic Conditions. H. McCallion and D. M. Davies. *IME Proc.*, No. 57, 1955, pp. 1,125–1,132; Communications, pp. 1,133–1,139; Author's reply, pp. 1,139, 1,140. 49 refs. Experimental investigation to determine dependence of the variation of stiffness, hysteresis energy absorbed per cycle, and resilience, upon frequency, amplitude of deformation, and temperature.

Testing

On the Basic Yield Stress Curve for a Metal. A. B. Watts and Hugh Ford. *IME Proc.*, No. 58, 1955, pp. 1,141–1,149; Communications, pp, 1,150–1,153; Author's reply, pp. 1,154–1,156. 31 refs. Investigation to determine yield stress-strain curves of strip material in the cold-rolling process. Various factors involved are studied, and it is shown that the results can be correlated with those of simple tension and compression.

Performance Fatigue Testing with Respect to Aircraft Design. E. Gassner. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 178–206. 44 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

A Strain Gage for the Measurement of Strains in Adhesive Bonds. C. B. Norris, W. L. James, and J. T. Drow. *ASTM Bul.*, Dec., 1956, pp. 40–49. Method for measuring tensile strain in a thin adhesive bond between metallic adherents by measuring the change in the electrical capacitance of the specimen.

An Optical Apparatus for Continuous Measurement of Shrinkage at High Temperature. J. Hutchings and J. P. Roberts. *Gt. Brit., RAE TN Met.253*, Aug., 1956. 6 pp.

Metallurgical Yield-Stress Observation. Joseph William Jacobson. (*ASME Semi-Annual Meeting, Cleveland, June 17–21, 1956.*) *Mech. Eng.*, Jan., 1957, pp. 13–15. Investigation on the failure of grain structure of SAE 1055 steel using a stressing metallograph.

Mathematics

Localization on Spheres. Victor L. Shapiro. *Rutgers U., AFOSR TN 56-311 [AD 94846]*, July 2, 1956. 15 pp. Extension to spheres of localization theorems obtained by Riemann and Zygmund.

A Useful Method for Integrating the Time-Dependent, Viscous Equations of Motion. L. Filler, H. F. Ludloff, and P. Treuenfels. *J. Aero. Sci.*, Feb., 1957, p. 147.

The Closed-Form Summation of Some Common Fourier Series. Chi-Chang Chao. *Quart. J. Mech. & Appl. Math.*, Dec., 1956, pp. 508–512. Description of a method suitable for a Fourier series whose coefficients are ratios of polynomials of certain types frequently encountered in practice. The result is obtained as the solution of a linear differential equation with constant coefficients.

Non-Recurrent Random Walks. K. L. Chung and C. Derman. *Pacific J. Math.*, Fall, 1956, pp. 441–447. 10 refs. OSR-supported proof that a set of integers containing an infinite number of positive integers (A) will be visited infinitely often with probability one by sequence $\{S_n\} n = 1,2,\ldots$ Conditions are given such that similar results hold for the case where X_t has a continuous distribution, and the set A is a Lebesgue measurable set whose intersection with the positive real numbers has infinite Lebesgue measure.

On the Evaluation of Two Functions Occurring in Maslen and Moore's Theory of Strong Transverse Waves in a Circular Cylinder. Henry E. Fettis. *J. Aero. Sci.*, Jan., 1957, pp. 64, 65.

The Determination of Matrix Eigenvalues by the Hollerith Computer. J. Guest. *Australia, ARL Note ARL/SM.-233*, Aug., 1956. 9 pp.

On the Generalized Radiation Problem of A. Weinstein. H. Melvin Lieberstein. *U. Md. Inst. Fluid Dynamics & Appl. Math., TN BN-87 (AFOSR TN 56-594) [AD 115021]*, Nov., 1956. 92 pp. 27 refs. Proof of a uniqueness theorem applicable to solutions for which a prolongation across the characteristic line $y = x$ does exist.

The Uniqueness of Double Trigonometric Series Under Circular Convergence. Victor L. Shapiro. *Rutgers U. Rep. (AFOSR TN 56-453) [AD 96799]*, Sept. 20, 1956. 5 pp.

Finite Difference Methods for the First Boundary Value Problem of $\Delta u(x,y) = r(x,y,u)$ and Curved Boundaries. Werner Uhlmann. *Hamburg U., AFOSR TN 56-390 [AD 96048]*, July, 1956. 39 pp. Development of an approximate solution of a differential equation for a given domain G of the x,y-plane which is equal to a specified function on the boundary of G.

Graficheskii Sposob Obrabotki Rezul'tatov Mnogokratnykh Izmerenii. L. L. Mediantseva. *Izmeritel'naia Tekhnika*, Sept.-Oct., 1956, pp. 7, 8. In Russian. Development of a graphical procedure to treat the results of compound measurements.

Contributions to Multivariate Analysis Including Univariate and Multivariate Variance Components Analysis and Factor Analysis. Remanathan Gnanadesikan. *N.C. U., Inst. Statistics, MS 158 (AFOSR TN 56-558) [AD 110378]*, Nov., 1956. 177 pp. 50 refs.

Über das Differenzenverfahren bei nichtlinearen Randwertaufgaben. I. Johann Schröder. *ZAMM*, Sept.-Oct., 1956, pp. 319–331. 11 refs. In German. Description of iteration methods for solving the equations of differences.

Einfache angenäherte Berechnung der Biegeeigenfrequenzen eines einseitig eingespannten Balkens ungleichförmigen Querschnittes, sowie der Eigenwerte ähnlicher Variationsprobleme. H. Wittmeyer. *ZAMM*, Sept.-Oct., 1956, pp. 355–367. 14 refs. In German. Transformation of the variation problem belonging to a special self-adjoint differential equation of the second order into an adequate canonic form similar to that of Hamilton-Jacobi. A first-order perturbation method is used to determine the value of the parameter in an approximating one-parametrical variation problem with constant coefficients.

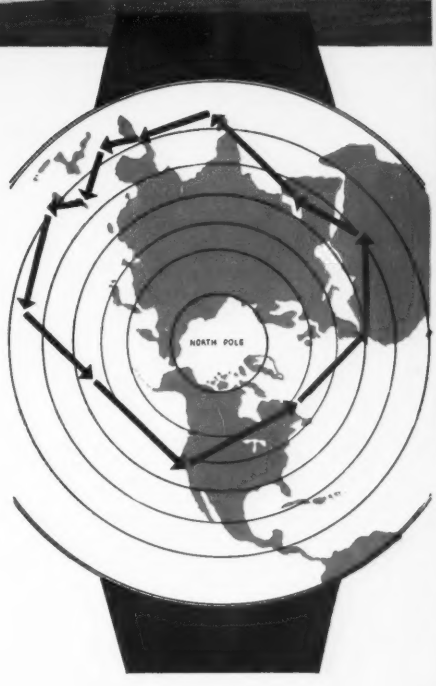
The Convergence of Airy Series. W. J. Klimczak. *Trinity Coll., Math. Div., Rep. (AFOSR TN 56-467) [AD 97086]*, Sept. 30, 1956. 8 pp. Investigation of the domain of absolute convergence in the complex plane of series of the form $f(z) = \sum_{n=1}^{\infty} f_n A_n(z)$ where the functions $A_n(z)$ are characteristic functions of the differential operator $\delta_z = d^2/dz^2 + z$. It is proved that, if a series converges absolutely for any nonreal value of z, then it converges absolutely everywhere in the complex plane.

The Convergence of Series of Characteristic Functions. I—Airy and Laguerre Series. W. J. Klimczak. *Trinity Coll., Math. Div., Rep. (AFOSR TN 56-531) [AD 110350]*, Oct. 30, 1956. 4 pp.

Subharmonic Functions and Generalized Tricomi Equations. Alexander Weinstein. *U. Md., Inst. Fluid Dynamics & Appl. Math., TN BN-88 (AFOSR TN 56-574) [AD 110396]*, Nov., 1956. 22 pp.

end of a "ROUTINE FLIGHT"—

24,325 miles non-stop in 45 hrs. 19 minutes!



FOOTE BROS. GEARING AND COMPONENTS HELP MAKE IT "ROUTINE"

We here at Foote Bros. join all of America in expressing our pride in the achievement of the men of the Strategic Air Command and the Boeing B-52 bombers they flew around the world in record-shattering time.

No greater expression of confidence in the aircraft could be made than to call the history-making feat a "routine flight." More than anything else, this must have gratified all of the people who had a part in producing these superb aircraft and the engines that power them.

We take special pride in the fact that the Foote Bros. Precision Quality Aircraft Engine Gears and Precision Assemblies for surface control mechanisms used in these aircraft helped make the mission a "routine flight."

For design, development, and/or production of Precision Aircraft Engine Type Gearing, actuators and power transmission, come to Foote Bros. first.

this trademark stands for the finest industrial gearing made

FOOTE BROS. Out-Rated LIFETIME GEARING

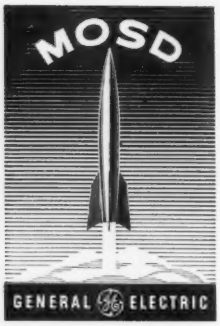
FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION

4545 South Western Boulevard, Chicago 9, Illinois

ENGINEERS & SCIENTISTS



SYMBOL OF ADVANCED THEORY AND RESEARCH IN THE GUIDED MISSILE FIELD

This General Electric department is prime contractor for "Intercontinental Ballistic Missile" and "Intermediate Range Ballistic Missile" nose cone development. Increasing emphasis on this and other guided missile programs continues to create openings on our professional staff for graduate engineers and scientists with experience in the following or related fields:

MATERIALS & PROCESSES • AERODYNAMICS • AEROPHYSICS • THERMODYNAMICS • ELECTRICAL DESIGN • STRUCTURAL DESIGN • STRESS ANALYSIS • DATA PROCESSING • SYSTEMS • SYSTEMS TEST • FIELD TEST • VIBRATION • INSTRUMENTATION • CONTROLS • ARMING AND FUZING • INERTIAL GUIDANCE • GROUND SUPPORT EQUIPMENT DESIGN

We would be pleased to receive a resume of your education and experience in order to arrange a personal interview with the manager of the appropriate technical area. Please address all correspondence to:

MR. JOHN WATT • ROOM 540-5
MISSILE & ORDNANCE SYSTEMS DEPARTMENT
GENERAL ELECTRIC
3198 CHESTNUT STREET, PHILADELPHIA 4, PA.

10 refs. USAF-supported analysis of the singular Cauchy problem for an Euler-Poisson-Darboux (EPD) equation with nonnegative index.

Primitive Operators of Deficiency (m,m). H. L. Hamburger, Arlen Brown, and Shlomo Sternberg. *Chicago U., Dept., Math., TR (AFOSR TN 56-500) [AD 110315]*, July, 1956. 59 pp.

Die "Neumannsche Methode" zur Approximation einer durch Beobachtungen gegebenen Funktion und ihr Zusammenhang mit der mechanischen Quadratur nach Gauss-Jacobi. Peter Mauersberger. *ZAMM*, Sept.-Oct., 1956, pp. 372–376. In German. Neumann's method of development by spherical functions is generalized and applied for solving the problem of approximating a function of n variables. The association with the Gauss-Jacobi quadrature is demonstrated and used for simplifying the analysis.

A Note on Test Factors. N. I. Bullen. *Gt. Brit., RAE Rep. Struc.215*, Sept., 1956. 18 pp. Discussion of methods to present results in a form readily available, and to find the appropriate test factor for any permissible proportion of items under strength.

Meteorology

Announcement—Extension to the Standard Atmosphere. *Mo. Weather Rev.*, Sept., 1956, pp. 333–335. Presentation of table of atmospheric parameters giving extension of ICAO Standard Atmosphere to 300 km.

A Model Atmosphere for Widespread Precipitation. David Atlas and Edwin Kessler, III. *Aero. Eng. Rev.*, Feb., 1957, pp. 69–74, 82. 13 refs. Derivation of a standard precipitation atmosphere which can be applied to problems in aeronautics and radar detection.

On the Nature and Origin of the Southern Oscillation. Irving I. Schell. *J. Meteorology*, Dec., 1956, pp. 592–598. 13 refs. USAF-supported physical examination of the nature and origin of the June–August Southern Oscillation and its relationship with the contemporary air and sea temperatures and with those of the following September–November and December–February periods.

A Study of Convective Precipitation Based on Cloud and Radar Observations. Louis J. Battan and Roscoe R. Braham, Jr. *J. Meteorology*, Dec., 1956, pp. 587–591. USAF-supported analysis of precipitation and cloud-top height data from investigations in the central United States and in the Caribbean area, in terms of the fraction of clouds of a given height which contain precipitation. Data are compared with Braham, Reynolds, and Harrell's New Mexico observations.

Atmospheric Turbulent Diffusion from Infinite Line Sources; an Electric Analog Solution. Walter J. Karplus and James R. Allder. *J. Meteorology*, Dec., 1956, pp. 583–586.

Mechanisms of Circulation Change During a Lee Cyclogenesis. C. W. Newton. *J. Meteorology*, Dec., 1956, p. 528–539. 17 refs. USAF-supported investigation of the life cycle of a destructive cyclone over the United States during the period of November 16 to 21, 1948. Con-

Missile Designers:

JACK & HEINTZ OFFERS YOU 3 TYPES OF

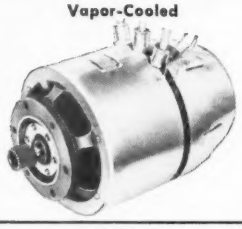
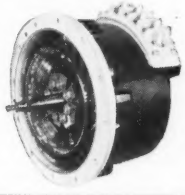
Environment-Free Generators

J&H machines deliver full-rated output independent of speeds, ambients, altitudes

In answer to the electric power needs of such weapons as North American's *Navaho* and Boeing's *Bomarc*, Jack & Heintz has successfully developed three approaches to the design of environment-free generators for missiles. With many completed units within each classification, J&H is in a position to meet quickly the requirements of missiles of all types: SSM SAM ASM AAM AUM UAM USM UUM.

Short-Duration Flights: J&H *thermal lag* generators are capable of delivering full-rated output throughout flight without benefit of cooling.

Long-Duration Flights: J&H *vapor-cooled* and *oil-cooled* generators using water and engine or hydraulic oil as coolants will deliver full-rated output regardless of speeds, ambients or altitudes.

Representative J&H Generator Designs for Missiles	Vapor-Cooled 	Oil-Cooled 	Thermal Lag
J&H Model	**G108-5**	**31190-005**	**31186-001**
Nominal Rating (kva)	30	40	10
Duty	continuous	continuous	intermittent
Volts	120	120/208	120/208
Speed (rpm)	12,000	6,000	12,000
Phase	3	3	3
Frequency (cps)	400	400	400
Power Factor (minimum)	.8	.75	.9
Weight (lb)	66	75	29.5
Length (in.)	13	9	10
Diameter (in.)	9	9.75	7

To Meet Your Specific Needs: J&H missile power specialists are available to confer on your specific requirements . . . generators and regulators. You may obtain basic engineering data on other J&H environment-free generators by writing to Jack & Heintz, Inc., 17632 Broadway, Cleveland 1, Ohio. Export Department: 13 East 40th Street, New York 16, New York.

© 1956 by Jack & Heintz, Inc.

JACK & HEINTZ AIRCRAFT ELECTRIC EQUIPMENT

sideration is given to the early period of most rapid cyclogenesis with reference to orographic factors. The contributions of horizontal convergence and of lateral friction differences to circulation change are computed. Includes qualitative discussion of the mechanism of circulation production by friction, and orographic influences on the cyclone's path.

Forced and Free Axially-Symmetric Convection Produced by Differential Heating in a Rotating Fluid. H.-L. Kuo. *J. Meteorology*, Dec., 1956, pp. 521–527. Derivation of a criterion expressed in terms of a Richardson Number, which combines the effects of rotation, static stability, viscosity, conductivity, radial temperature contrast, and the relative vorticity of the mean zonal flow into a single parameter. The criterion is compared with Fultz's experimental results.

Vorticity Distribution and Advection in the Lower and Middle Troposphere. Holbrook Landers. *J. Meteorology*, Dec., 1956, pp. 511–520. 14 refs. USAF-supported experimental investigation to determine the three-dimensional distribution of relative vorticity in the lower 25,000 ft. of the atmosphere over a 3-day period. An observed-wind method of computing vorticity is compared with a geostrophic method which employs the LaPlacian of the contour field.

Low-Level Temperature Structure Under Alaskan Ice Fog Conditions. Elmer Robinson and Gordon B. Bell, Jr. *Bul. AMS*, Dec., 1956, pp. 506–513. Investigation using wiresonde temperature soundings as part of an ice-fog study. Correlations are found between the depths of the visible fog layers and the steep portions of the temperature inversions.

The Weather Man's Struggle for Upper-Air Data. D. M. Little. *Sperryscope*, 4th Quarter, 1956, pp. 6–9. Review of early methods in upper-air meteorology and discussion of modern prediction techniques.

Missiles

Special Issue: Guided Missiles. *Flight*, Dec. 7, 1956, pp. 876–910. Partial Contents: Missiles That Think; An Introduction to Guided Weapons. Reflections of a Weaponeer; Some Thoughts on Missile Development and Production, B. A. Hunn. Missile Design, Peter J. Farmer. Missile Testing; Weapons on Trial—A Series of Controlled Experiments. Guided Missiles 1956.

Les Engins Spéciaux Anglais. J. Klopp. *Docaéro*, Nov., 1956, pp. 3–8. In French. General survey of missile production in Great Britain since 1945.

Testing in the Guided Missile Industry. Rebecca H. Sparling. *ASTM Bul.*, Dec., 1956, pp. 52–55; Discussion, p. 56. Discussion of the importance of testing during the manufacture of missiles, the types of test used, and the areas where standardization is needed.

International Congress on Rockets and Guided Missiles. *The Engr.*, Dec. 21, 1956, p. 899. Summary of the discussions, with emphasis on the British High-Altitude Research Programme to be carried out during the International Geophysical Year.

"Beam Rider" Control of Guided Missiles. M. Schönsleben. *Brown Boveri Rev.*, Sept., 1956, pp. 393–398. Discussion of the principle of a beam-riding missile and the method of conveying the necessary information from the transmitter to the missile.

Approximate Trajectories of High-Drag Bodies. George S. Campbell. *J. Aero. Sci.*, Feb., 1957, pp. 147–149. Presentation of charts to facilitate rapid trajectory determination.

Electronics is Key to All Guided Missile Design. Arthur E. Harrison. *Av. Age*, Jan., 1957, pp. 98–101 ff.

Geleide Projectielen Zijn een Realiteit. *Avia Vliegwereld*, Dec. 6, 1956, pp. 630, 631. In Dutch. Evaluation of the present knowledge in the field of missiles, taking into account the ICBM development.

New Developments in Instrumentation; Guided Missile Range Instrumentation—Present and Future. Bernard R. Lucsak. *Am. Ordnance Assoc., 38th Annual Meeting, New York, Dec. 5, 1956, Paper.* 7 pp.

Über den Einfluss einer Variation der Gerätedaten, insbesondere der Flügelfläche, auf die maximale Verzögerung und Hauttemperatur von Rückkehrgeräten. H. J. Kaeppeler. *ZFW*, Dec., 1956, pp. 382–388. In German. Development of a simple theoretical method for estimating the effects of a variation of the design parameters of a missile on the elements of the supersonic glide trajectory.

A Note on Missile Launching. Telford W. Oswald. *J. Aero. Sci.*, Jan., 1957, pp. 74–76. Method to account for large changes in inertia and stability margin such as occur with a solid-propellent rocket-powered missile launched at subsonic speeds and accelerated to supersonic speeds.

Comprehensive Testing Speeds Missile Development. Leighton I. Davis. *Missiles & Rockets*, Dec., 1956, pp. 61–63. Discussion of the importance of testing in the development program. Recommendations are made for a comprehensive testing program for all components of a system to ensure final system success.

Navigation

Tröghetsnavigering. Rolf Ohlon. *Tek. Tidskrift*, Nov. 6, 1956, pp. 955–957. 10 refs. In Swedish. Study of inertial navigation.

Electronic Aids

Airborne Proximity Indicator; Collins Proposal for a Collision Warning Device. *Flight*, Nov. 30, 1956, pp. 845, 846. Summary of preliminary specifications for the PI-101, a system which warns of intruding aircraft in the flight plane of the protected aircraft and in each of the four quadrants—forward, aft, port, and starboard.

Kollsman Integrated Flight Instrument System. Jack Andresen and Everett H. Schroeder. *Shell Av. News*, Nov., 1956, pp. 9–11. Description of an instrument system that takes information supplied by the conventional and dependable pressure instruments, integrates their outputs electrically through the computer, and then feeds back the integrated data, corrected for errors, to the crew through a conventional modular instrument presentation.

Vyvod Samoleta na Aerodrom i Probivanie Oblachnosti po Radiolokatoru. A Teplitskii. *Grazhdanskaia Aviatsiia*, Sept., 1956, pp. 6, 7. In Russian. Description of a radar-guidance technique to overcome landing problems under unfavorable weather conditions.

FM-CW Radar—Heart of Anti-Collision System. James Holahan. *Av. Age*, Dec., 1956, pp. 80, 81, 82–85 ff. Description of a radar system which will sense range for proximity warning and range and radial velocity for collision avoidance.

Radiolokatsionnoe Opredelenie Skorosti i Napravleniia Vetra. S. Mamushkin. *Grazhdanskaia Aviatsiia*, Sept., 1956, p. 8. In Russian. Application of radar to the determination of wind direction and velocity.

Radionavigaţia şi Aviaţia Utilitară. R. Ferderber. *Rev. Transp.*, Sept., 1956, pp. 357–360. In Rumanian. Radio navigation and aspects of effective air lines.

Radioayudas para la Navegación Aérea. Jorge Luis Sánchez. *Rev. Nac. Aero.*, Sept., 1956, pp. 47–49. In Spanish. Consideration of electronic navigational aids in relation to the type of aircraft, traffic density, and meteorological conditions.

Avtomat-Otvetchik dlia Proverki Samoletnykh Radiostantsii. E. Belousov. *Grazhdanskaia Aviatsiia*, Oct., 1956., pp. 26, 27. In Russian. Description of an automatic device for checking airport traffic-control installations.

The Dilemma of Air Traffic Control. *Airports & Air Transp.*, Nov.-Dec., 1956, pp. 105–107, 122.

Photography

The Simultaneous Determination of the Orientation and Lens Distortion of a Photogrammetric Camera. Duane C. Brown. *USAF MTC TR 56-20 [AD 96626]*, Nov. 14, 1956. 24 pp. Extension of the rigorous least-squares calibration of the orientation of a photogrammetric camera to determine additional parameters defining the radial distortion of the camera lens.

Panel on Aerial Photography. (*ASP 22nd Annual Meeting, Washington, Mar. 23, 1956.*) *Photogrammetric Eng.*, Dec., 1956, pp. 899–929. Partial contents: Camera Mounting for Photogrammetric Purposes, Ernest H. Pallme. The Role of the Airplane in Aerial Photography, Raymond H. Miller. The Influence of Atmospheric Haze on the Quality of Aerial Photographs, J. L. Tupper. Precision Lenses and Shutters, Herbert Trager. Mass Production of High Quality Contact Prints, Earl M. Knibiehly. Proposal for the Miniaturization of Aerial Photography, Gomer T. McNeil.

Physics

Space Travel and Future Research into the Structure of the Universe. J. M. J. Kooy. *J. Brit. Interplanetary Soc.*, Sept.-Oct., 1956, pp. 248–259. Theoretical investigation of the possibility of determining by observation the radius of space curvature and its mode of variation with time, and analysis of the alternative

In the Aircraft Industry...

Solar is Synonymous with Stainless Steel

EXPERIENCE Solar has more experience in building airframe and engine components of stainless steels, titanium, and other advanced metals and high alloys than any other company in the world.

DESIGN Solar can greatly assist you in the design of components and assemblies to be built of high alloys—because of Solar's intimate knowledge of the problems and possibilities of these special metals.

DEVELOPMENT Solar is being asked to undertake more and more basic development projects in association with other companies—because of Solar's unique skills with advanced metals and their engineering.

MANUFACTURE Two large plants offer strategic dispersion with integrated, experienced management. Solar's production record is unmatched for quality, service, dependability, and prompt delivery.

FOR MORE INFORMATION ABOUT SOLAR'S CAPABILITIES, WRITE DEPT C-133, SOLAR AIRCRAFT CO., SAN DIEGO 12, CALIFORNIA.

SOLAR AIRCRAFT COMPANY SAN DIEGO DES MOINES

Designers, Developers and Manufacturers • Gas Turbines • Aircraft and Missile Components • Bellows • Controls • Coatings • Metal Alloy Products

ENGINEERS *Aerodynamics & Propulsion*

The Johns Hopkins University
Applied Physics Laboratory

ANNOUNCES

. . . important openings on our guided missile research and development staff for men who wish to identify themselves with an organization whose prime purpose is scientific advancement.

Because the Applied Physics Laboratory (APL) exists to make rapid strides in science and technology, staff members require and receive freedom to inquire, to experiment, to pursue tangential paths of thought. Such freedoms are responsible for findings that frequently touch off a chain reaction of creativity throughout the organization.

As a staff member of APL you will be encouraged to determine your own goals and to set your own working schedule. You will associate with leaders in many fields, all bent on solving problems of exceptional scope and complexity. The resources of our 350,000 sq. ft. laboratory are complemented by those of the 18 universities and industrial organizations who are working under our technical direction on prime contracts.

Equidistant between Baltimore, Md., and Washington, D. C., our new laboratory allows staff members to enjoy suburban or urban living and the rich cultural, educational and research facilities offered by both cities.

Openings Exist In These Fields:

DEVELOPMENT: *Stability and control analysis; ramjet engine design; preliminary design and wind-tunnel testing.*

RESEARCH: *Interference and heat transfer phenomena; internal aerodynamics; hypersonics, turbulence, shock wave phenomena; combustion.*

SEND NOW FOR OUR NEW 30-PAGE PUBLICATION DESCRIBING IN DETAIL THE SCOPE OF THE LABORATORY'S PROGRAMS AND THE UNIQUE ENVIRONMENT IN WHICH STAFF MEMBERS WORK AND LIVE.

WRITE:

Professional Staff Appointments
The Johns Hopkins University
APPLIED PHYSICS LABORATORY
8605 Georgia Avenue • Silver Spring, Maryland

assumptions which may provide a basis for the prediction that intergalactic space is spherical, the radius of curvature varying with time.

Cross Sections of Dissociative Recombination. Ernest Bauer and Ta-You Wu. *Can. J. Phys.*, Dec., 1956, pp. 1,436–1,447. USAF-supported consideration of a hydrogen molecular ion H_2^+ in its ground state, $1s\sigma^2\Sigma_g^+$, which captures a free electron of low energy and splits up into two hydrogen atoms in the states H (1s) + H (2s) or H (1s) + H (2p). The purpose of the analysis is to calculate the cross sections for transitions into these two states in a "Born approximation" as functions of electron energy for energies less than 1 e.v.

On the Ring Current Hypothesis. Appendix A—**On the Magnetic Fields of the Earth, and of the Ring.** Appendix B—**On Beam Spread.** Nelson Wax. *Acta Polytechnica*, No. 171 (187), 1956. 32 pp. 28 refs. Critical account of the observations and theories leading up to the hypothesis in order to evaluate the various estimates of the ring's parameters. The hypothesis refers to a theoretical phenomenon associated with auroral activity—that of a ring current flowing outside the earth—and states that the density of the charged particles in the ring is significantly higher than that of those in the immediate neighborhood of the ring. Observational data are emphasized.

A Universal Scanning Curve for Wide Angle Mirrors and Lenses. J. F. Ramsay. *Marconi Rev.*, 4th Quarter, 1956, pp. 150–159. Derivation of a general curve showing loss of gain on scanning of a coma-corrected focusing element lens or mirror.

The Kinetic Theory of Multi-Component Systems of Non-Spherical or "Loaded Sphere" Molecules. John S. Dahler. *U. Wis. NRL Dept. Chem. Rep. WIS-ONR-23*, Dec. 13, 1956. 34 pp. Development of a kinetic theory of loaded spheres in a manner patterned on the Chapman-Enskog approach and the work of Curtiss.

Opredelenie Absoliutnoi Velichiny Uskoreniia Sily Tiazhesti po Padeniiu Zhezla v Vakuume. A. I. Martsiniak. *Ismeritel'naia Tekhnika*, Sept.-Oct., 1956, pp. 11–15. In Russian. Determination of the absolute magnitude of the accelerating gravity force in the case of a rod dropped in a vacuum.

Special Issue. (*Internatl. Conf. on Electron Transport in Metals & Solids, Ottawa, Sept. 10–14, 1956.*) *Can. J. Phys., Supplement*, Dec., 1956. 252 pp. 442 refs. Contents: Interaction Between Electrons and Lattice Vibrations, J. Bardeen. On Some Electrical and Magnetic Properties of Metallic Solid Solutions, J. Friedel. Electrical Resistance Due to Lattice Imperfections in Metals, P. G. Klemens. On the Electrical Resistivity of Stacking-Faults in Monovalent Metals, Alfred Seeger. On the Statistical Mechanics of Irreversible Processes, I. Prigogine. Electron-Phonon Equilibrium and the Transport Phenomena in Metals at Low Temperatures, E. H. Sondheimer. The General Variational Principle of Transport Theory, J. M. Ziman. A General Expression for the Conductivity Tensor, R. Kubo. A Variational Principle for Conduction Phenomena in the Presence of a Magnetic Field or Asymmetric Scattering Mechanisms, Alfred

The AERONAUTICAL ENGINEERING REVIEW Announces its 7th Annual

- **SPECIAL ISSUE**
- **on**
- **ELECTRONICS IN AVIATION**

May 1957 Issue

Readership will include leading engineers, designers, and technical specialists actively engaged in all aircraft research, development, and operational projects (military planes, guided missiles, helicopters, light aircraft, commercial transports, etc.).

ORDER ADVERTISING SPACE NOW!

Forms Close April 1st

Write, Wire or Phone for fact sheet giving complete information.

Aeronautical Engineering Review
2 East 64th St., New York 21, N.Y.
TEmpleton 8-3800

Have you the growth potential to make top money as a

CONVAIR MISSILES MAN?

Get the facts on **CONVAIR POMONA** in sunny California—*first* fully-integrated missile plant in the U.S.A.—designer and builder of the Navy's TERRIER supersonic, surface-to-air missile.

Naturally, you'll work with the most modern electronic equipment known. Better yet, you'll work with the kind of engineering talent that *creates* such equipment... that is pacing the advance of science into outer space.

You'll have the scope and help to show what you can do ...and top pay at every step you progress. You and your family will live (California-style) in the lush Pomona Valley at the foot of the snow-capped Sierra Madre. No commuting problems. Ample housing. True country living just 30 minutes from downtown Los Angeles.

Openings now in:

Electronics	Operations Research
Aerodynamics	Hydraulics
Dynamics	Mechanical Design
Thermodynamics	Laboratory Test

Generous travel allowance to Engineers accepted.
Write now, enclosing complete resume to:

Engineering Personnel Dept. 3-N

C-V CONVAIR GD
POMONA

POMONA • CALIFORNIA

CONVAIR IS A DIVISION OF GENERAL DYNAMICS CORPORATION

Seeger. Remarks on the Anomalous Behavior of Alloys Containing Traces of Manganese or Similar Elements, C. J. Gorter, G. J. van den Berg, and J. de Nobel. Magnetization and Magnetoresistance of Some Dilute Alloys of Mn in Cu, R. W. Schmitt and I. S. Jacobs. On the Resistivity Anomalies in Some Diluted Alloys, J. Korringa. Nuclear Magnetic Resonance and Electronic Structure of Conductors, N. Bloembergen. Electrical and Thermal Conductivity of Metals, K. Mendelssohn. Conductivity of Metals at Low Temperatures, G. K. White. On the Magnitude of the Contribution of a Circulation Effect to the Thermal Conductivity of a Superconductor, C. J. Gorter. Phenomenological Aspects of the Resistivity of Pure Metals, G. Borelius. Heat Transfer in Semiconductors, A. F. Joffé. On the Transition to Metallic Conduction in Semiconductors, N. F. Mott. The Chemical Bond in Semiconductors; The Group V B to VII B Elements and Compounds Formed Between Them, E. Mooser and W. B. Pearson. Galvanomagnetic Effects in *n*-Type InSb at 4.2°K., H. P. R. Frederikse and W. R. Hosler. Electron Interaction in Solids, David Pines. Our Knowledge of the Fermi Surface, R. G. Chambers.

Power Plants

New Developments in Propulsion; Address at Propulsion Seminar. Paul F. Nay. *Am. Ordnance Assoc., 38th Annual Meeting, New York, Dec. 5, 1956, Paper.* 3 pp. Discussion of the various propulsion methods used by the USAF, their applications, and their salient design features.

Verbrennungskraftmaschinen; Ottomotoren für Flugzeuge, Kraftwagen und Krafträder. H.-O. Derndinger. *VDI Zeitschrift,* Oct. 11, 1956, pp. 1,695–1,700. 19 refs. In German. Evaluation of combustion-chamber designs.

Atomic

Rolls-Royce on Nuclear Propulsion. I, II. *The Aeroplane,* Dec. 14, 21, 1956, pp. 905–907; 938. Discussion of the problems involved in designing nuclear power plants for aircraft. The problems include shielding, weight of reactor, safety, type of propulsion, and economics.

Thermodynamics of Working Gases in Atomic Rockets. I. Sänger-Bredt. (*5th Internatl. Astronautical Cong., Zurich, 1953.*) *J. Brit. Interplanetary Soc.,* Sept.-Oct., 1956, pp. 233–248. 19 refs. Translation. Theoretical investigation considering ordinary hydrogen and assuming that the combustion gases with a uniform temperature in the chamber of the rocket are at all times and regions in complete thermal and chemical equilibrium and undergo expansion at constant entropy.

Jet & Turbine

Turbine-Powered Aircraft for the Future. K. H. Larsson. (*SAE-CAI Meeting, Montreal, Mar. 19, 1956.*) *Can. Aero. J.,* Dec., 1956, pp. 366–372. Outline of the design characteristics of the three basic types of turbine engine with comparison of their propulsion characteristics, and discussion of their development status, operational background, and suitability as power plants for future commercial transports.

La Renaissance du Turbomoteur. M. Faury. *Docaéro,* Nov., 1956, pp. 37–48. In French. Evaluation of turbine power plants, their superiority over piston engines, and comparison with other types of propulsion.

La Motopropulsione degli Aerei Nelle sue Linee Concettuali e Nella Sua Evoluzione. Pietro Formentini. *Riv. Aero.,* Oct., 1956, pp. 1,091–1,109. In Italian. Evaluation of power plants, taking into account weight, velocity, fuel consumption, and other primary factors.

Flame Radiation in an Industrial Gas Turbine Combustion Chamber. Appendix I—**The Laws of Radiation from Surfaces.** Appendix II—**The Net Radiant Heat Transfer Between a Flame and Its Surroundings.** Appendix III—**Derivation of Expressions for Partial Pressures.** Appendix IV—**Proof of Beer's Law.** Appendix V—**Example of Emissivity Estimation.** D. Reeves. *Gt. Brit., NGTE Memo. M.285,* Oct., 1956. 65 pp. 10 refs.

Étude de Problèmes de Combustion Dans les Turbines à Gaz d'Aviation. J. S. Clarke. *Tech. et Sci. Aéronautiques,* No. 5, 1956, pp. 205–220. In French. Study of combustion problems in gas turbines.

Heat-Transfer Problems of Liquid-Cooled Gas-Turbine Blades. Henry Cohen and F. J. Bayley. *IME Proc.,* No. 53, 1955, pp. 1,063–1,074; Communications, pp. 1,075–1,079; Author's reply, pp. 1,079, 1,080. 11 refs. Survey of possible methods of cooling rotor blades, with results indicating that the thermosyphon system is the most effective. In this system a quantity of liquid is enclosed within each blade to act as a conveyor of heat to the more easily cooled root.

Keeping Heat in Its Place. L. F. E. Coombs. *Flight,* Dec. 28, 1956, pp. 985, 986. Discussion of the use of insulation to protect the aircraft frame from the heat radiated by the engine.

Rapid Determination of Core Dimensions of Crossflow Gas-To-Gas Heat Exchangers. Anthony J. Diaguila and John N. B. Livingood. *U.S., NACA TN 3891,* Dec., 1956. 19 pp. Description of a generalized analytical method and application of a generalized chart to the cases of two selected core configurations with identical fluid conditions and one configuration with different fluid conditions.

Some Experiments on An Effusion Cooled Turbine Nozzle Blade. Appendix I, II, III—**The Static Pressure Distribution Over The Blade Surface at Mn 0.24 and 0.53.** Appendix IV—**Permeability Data for Woven Wire Cloth and Other Permeable Materials.** S. J. Andrews, H. Ogden, and Jane Marshall. *Gt. Brit., ARC CP 267* (May, 1954), 1956. 36 pp. BIS, New York, $0.90.

Research on Application of Cooling to Gas Turbines. J. B. Esgar, J. N. B. Livingood, and R. O. Hickel. *ASME Semi-Annual Meeting, Cleveland, June 17–21, 1956, Paper 56-SA-54.* 12 pp. 45 refs. Discussion of advantages and disadvantages in turbine cooling, and evaluation of the methods for cooling.

More Power from the Ghost. *de Havilland Gazette,* Dec., 1956, pp. 197–199, cutaway drawing. Discussion of modifications of the de Havilland Ghost turbojet engine to improve its performance. Power has been raised by increasing the r.p.m. and the gas operating temperature. New materials have been used to reduce the weight. Engine handling has been simplified by the addition of an automatic maximum r.p.m. control.

Jet Exhaust Controlled by "Striction" Nozzle. Randolph Hawthorne. *Av. Age,* Jan., 1957, pp. 46–49 ff. Description of a striction nozzle developed by SNECMA. The device employs a small, by-pass jet stream which is injected into the main jet stream to restrict the exhaust area.

Pressure Losses of Titania and Magnesium Slurries in Pipes and Pipeline Transitions. Ruth N. Weltmann and Thomas A. Keller. *U.S., NACA TN 3889,* Jan., 1957. 22 pp. 15 refs. Comparison of experimental and calculated pressure losses for Newtonian and non-Newtonian materials. The non-Newtonian materials are slurries of titanium dioxide suspended in water and magnesium particles suspended in a hydrocarbon fluid.

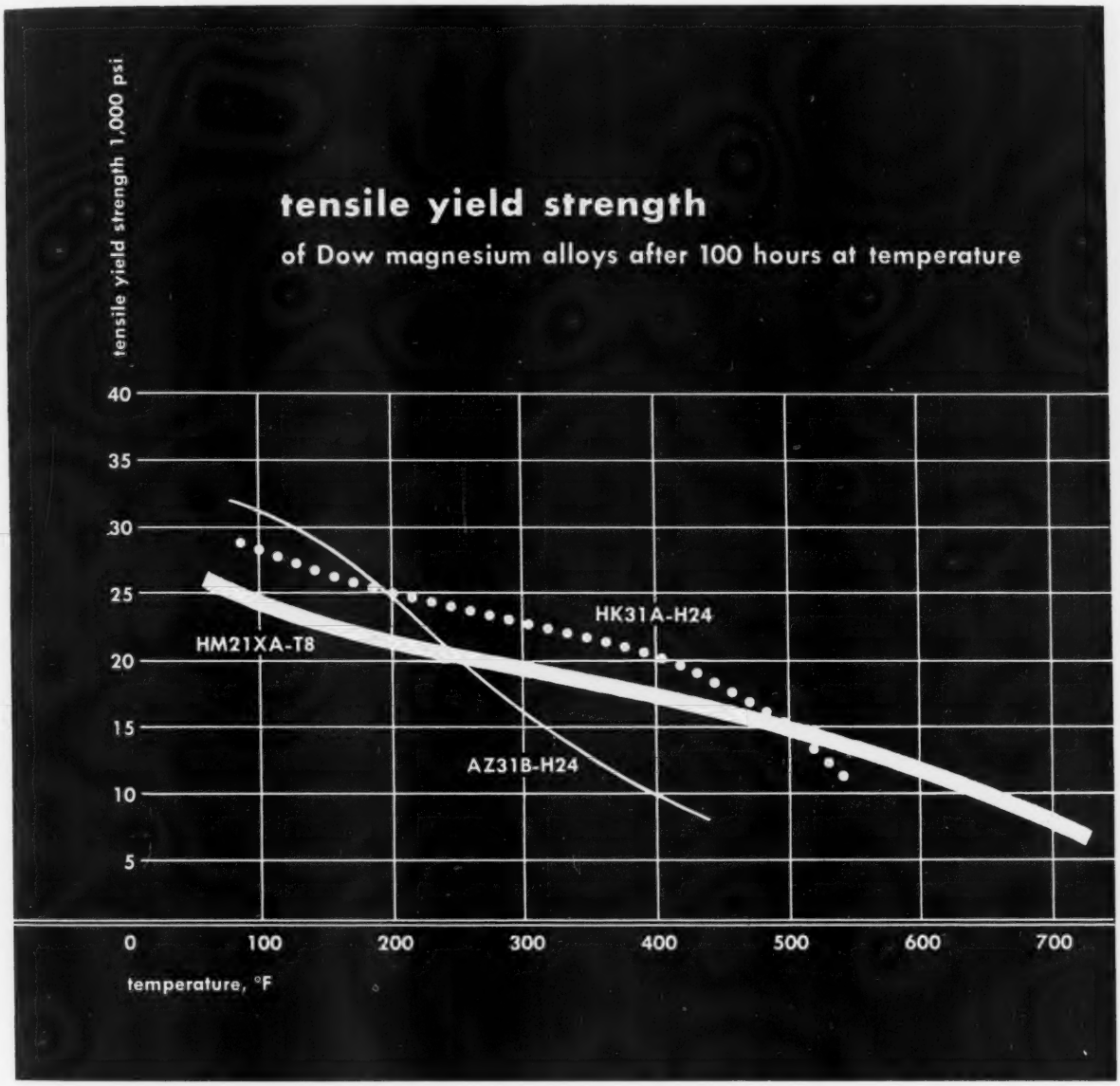
Analysis of Systems Used for Speed Governing Turbojet Engines. Jack O. Nash. *Aero Dig.,* Dec., 1956, pp. 14–19. Description of a linearized method for determining the performance of a jet engine with its associated speed governor. The method is suitable for preliminary control design.

Zur Herleitung der Eulergleichungen des brachystochronen endpunktgebundenen Steigfluges in vertikaler Ebene bei verschiedenen Endbedingungen. Hermann Behrbohm. *ZFW,* Dec., 1956, pp. 373–382. In German. Derivation of Euler's differential equations for the optimum rate of climb in a vertical plane for a jet-propelled aircraft operating under specified initial conditions (velocity, angle of flight path, and weight) from the origin to a given ultimate point, with the final conditions varying in accordance with the case considered.

Analytical Investigation of the Effect of Water Injection On Supersonic Turbojet-Engine—Inlet Matching and Thrust Augmentation. Appendix A, B—**Calculation of One-Dimensional Flow with Complete Evaporation of Water in a Constant-Area Channel.** Appendix C—**Engine-Inlet Matching with Evaporative Cooling Ahead of the Turbojet Eagine.** Andrew Beke. *U.S., NACA TN 3922,* Jan., 1957. 25 pp.

Identification of Foreign Objects Damaging Compressor Blades in Turbojet Eagines. A. E. Spakowski and J. Graab. *U.S., NACA RM E56J12,* Jan. 7, 1957. 12 pp. Development of a rapid-emission spectroscopic method to determine the chemical composition of foreign objects from the trace of material left behind on the damaged blade.

Ash Deposition on Gas Turbine Blades; Comparative Deposition Rig-Tests with Five Different Victorian Brown Coals. M. L. Atkia and J. C. Wisdom.



New magnesium alloy holds properties for 100 hours up to 700°F.

Dow Magnesium HM21XA-T8 alloy extends further the range of conditions under which light metals can be used in aircraft design. Second in the series of sheet alloys designed specifically for elevated temperature applications, it supplements the excellent characteristics of HK31A alloy.

HM21XA-T8 retains its properties at temperature during long periods of time. Even one hundred hours at 700°F. results in relatively little change in tensile yield, creep and elastic modulus.

Magnesium lightness is combined with strength at elevated temperature in HM21XA-T8, offering new ways to save weight or gain increased rigidity in the design of missiles and aircraft. This alloy is supplied in the -T8 temper and can be formed in this temper without the need for further heat treatment after fabricating. Samples of HM21XA-T8 along with detailed information are available. Contact your nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1400C-1.

YOU CAN DEPEND ON DOW

Australia, ARL Mech. Eng. Note 193, Oct., 1954. 14 pp.

Influence du Nombre de Reynolds sur les Pertes dans les Grilles d'Aubes. André L. Jaumotte and Pierre Devienne. *Tech. et Sci. Aéronautiques,* No. 5, 1956, pp. 227–232. In French. Definitions of the loss coefficient and analysis of the influence of Reynolds Number on the loss coefficient of three types of blades—accelerating, decelerating, and relaxation blades.

Vozdushnye Vinty Turbovintovykh Dvigatelei. D. Nikolaev. *Grazhdanskaia Aviatsiia,* Oct., 1956, pp. 20–22. In Russian. Theoretical evaluation of the design and performance of turbine blades. The requirements of short runways are taken into account, and the principle of thrust reversal is analyzed.

Proved Airworthy on the Ground. *Instrumentation,* Nov.-Dec., 1956, pp. 4, 5. Discussion of Pratt & Whitney engine-testing procedures.

Rocket

New Developments in Propulsion; Notes for Propulsion Seminar. Miles B. Chatfield. *Am. Ordnance Assoc., 38th Annual Meeting, New York, Dec. 5, 1956, Paper.* 2 pp. Discussion of solid propellants wih examples indicating how improvements in propulsion units have been, or are being, a major factor in weapon design and use.

Ideas Behind the Rocket. D. Hurden. *Spaceflight,* Oct., 1956, pp. 9–14.

On the Development of Rational Scaling Procedures for Liquid-Fuel Rocket Engines. S. S. Penner. *AMF TD TR 101 (AFOSR TN 56-383) [AD 95819],* Sept. 19, 1956. 27 pp. Survey of recent theoretical studies concerning similarity analysis and the scaling of liquid-fuel rocket engines.

The Use of Solid Propellant Engines for Achievement of Super Velocities. Joseph W. Wiggins. *(ARS Semi-Annual Meeting, Cleveland, June 18–20, 1956.) Jet Propulsion,* Dec., 1956, pp. 1,084–1,087. Review of the analytical relationships which determine the velocity of a missile, considering the effects of engine efficiency for low burned velocities and super velocities. The efficient staging for achieving velocities higher than those which can be achieved for a single stage is discussed.

Production

Production for an Industry. K. T. Fulton. *The Aeroplane,* Dec. 7, 1956, pp. 853–857. Discussion of production techniques employed by Briggs Motor Bodies, Ltd., in producing fabricated and sheet-metal components for turbine engines.

Machine à Reproduire à Palpeur Sans Contact; Application à l'Usinage des Ailettes de Turbine. Roland Moreau. *Tech. et Sci. Aéronautiques,* No. 5, 1956, pp. 221–225. In French. Description of an apparatus for machining metal parts of arbitrary design. Application to turbine blades is also described.

Metalworking

Tecnologie della Brasatura e Saldobrasatura. IV—La Progettazione dei Giunti Brasatie Saldobrasati. Mario Macuz. *Tec. Italiana,* Nov., 1956, pp. 457–466. In Italian. Study of various aspects of soldering and brazing and of problems in the design of soldered and brazed joints.

Cold-Forming Methods for Fabrication of Inert Rocket Components During Development. H. R. Grant. *(ARS Semi-Annual Meeting, Cleveland, June 18–20, 1956.) Jet Propulsion,* Dec., 1956, pp. 1,088–1,090. Discussion of a low-cost, cold-forming process, and its application to a precision-ordnance rocket-motor tube.

Production Design Techniques for Cold Roll Forming. Richard T. Angel. *Mach. Des.,* Dec. 13, 1956, pp. 106–112. Discussion covering the factors to be considered in specifying cold roll forming for production of parts, the advantages and disadvantages of the process, planning the part for easy production, auxiliary forming and production operations, tolerances, and new metals for which the process is suitable.

Can Airframes of the Future be Machined. J. H. Famme. *Auto. Ind.,* Jan. 1, 1957, pp. 68–70, 114–116 ff. Discussion of new materials and the new processes that will be necessary to form them for future aircraft designs.

Integral Components; Machine for Milling the Profiles, Angles and Recesses of Large Airframe Units. *Aircraft Prod.,* Jan., 1957, pp. 23–26.

Transfer-Machining; Seven-Station Rotary-Transfer Milling Operations on Blade-Roots at Bristol Aero-Engines Ltd. *Aircraft Prod.,* Jan., 1957, pp. 10–19.

Fixture-Barrelling; Surface-Finishing Large Integral Airframe Components. *Aircraft Prod.,* Dec., 1956, pp. 493–495.

Sculpture-Milling; Development of the Cramic Machine Using Recirculating-Ball Linear-Bearings—Skin-Milling Operations at de Havilland Aircraft Co., Ltd. *Aircraft Prod.,* Dec., 1956, pp. 502–511.

Chemical-Milling. Durward Armstrong. *Aircraft Prod.,* Dec., 1956, pp. 519, 520. Discussion of Grumman's experience in applying the chemical-milling process.

Copy-Broaching; Template-Controlled Development of Surface-Broaching to Produce Linear Profiles on Cross-Sectional Forms. *Aircraft Prod.,* Dec., 1956, pp. 480–483.

Surface Finishing; Design Developments in Automatic Machines for Surface-Finishing Long Slender Aircraft Components. *Aircraft Prod.,* Jan., 1957, pp. 2–7. Description of a new type of ram-operated machine for the surface finishing of aircraft components which, because of their size or geometric shape, cannot be polished effectively by barrelling machines.

Production Contour-Etching; Development of the Process for Routine Application to Airframe Manufacture. *Aircraft Prod.,* Jan., 1957, pp. 28–40.

Production Engineering

Future Airframe Designs. J. H. Famme. *Aircraft Prod.,* Dec., 1956, pp. 514–518. Review of the problems presented by the trend in air-frame design, with emphasis on the need for close co-operation between aircraft and machine-tool manufacturers.

Production Needs Are Best Met When Considered Early in Process of Product Planning. C. O. Stump. *SAE J.,* Dec., 1956, pp. 49–51.

Tooling

Repeatable Setting; Photoelectric Microscope Used for Setting Machine-Tool Slides at Predetermined Stations. *Aircraft Prod.,* Dec., 1956, pp. 484–486.

Welding

Constricted Tungsten-Arc Cutting of Aluminum. G. W. Oyler, R. L. O'Brien, and J. Maier, III. *Welding J.,* Dec., 1956, pp. 1,214–1,221. Development of a cutting process for nonferrous metals, which employs a constricted arc between a tungsten electrode and the workpiece in conjunction with a high-velocity gas stream.

Refueling in Flight

In-Flight Refueling. Herbert D. Bissell. *Project Engr.,* Dec., 1956, pp. 3–8. Discussion of the operation of float switches that provide a warning, during in-flight refueling, when fuel tanks are filled to capacity.

Rotating Wing Aircraft

Special Issue: Survey of Helicopter Progress. *The Aeroplane,* Dec. 14, 1956, pp. 881–904. Contents: The Helicopter as a Commercial Vehicle. Britain's Rotary-Wing Year in Retrospect. Current Rotary-Wing Aircraft. All-Weather Helicopter Operation, P. A. Hearne. Developing Some Badly Needed Equipment. Helicopter on Location, John Crewdson.

The Aerocycle. Peter Beasley. *AHS Newsletter,* Dec., 1956, pp. 1–3. Description of the DeLackner "Aerocycle" and its principles of operation.

Posadka Vertoleta v Sluchae Otkaza Dvigatelia. V. Vinitskii and Iu. Pavlov. *Grazhdanskaia Aviatsiia,* Sept., 1956, pp. 14, 15. In Russian. Analysis of the landing problem in the case of helicopter power-plant failure.

A Two-Dimensional Approximation to the Unsteady Aerodynamics of Rotary Wings. Robert G. Loewy. *(IAS 24th Annual Meeting, New York, Jan. 23–26, 1956, Preprint 605.) J. Aero. Sci.,* Feb., 1957, pp. 81–92, 144. 16 refs. Includes presentation of curves of aerodynamic damping coefficient for flapping and pitching motions and discussion of the application of these coefficients to classical flutter analysis and other rotor problems.

The Design Study of a Spring Tab Rotor System. Thurstan H. Banister. *J. Helicopter Assn. Gt. Brit.,* Oct., 1956, pp. 103–117. Analysis of a rotor designed to lift 2,000 lbs. in a single-rotor helicopter. The behavior of the rotor system under various conditions is discussed with respect to performance, vibration, and weight. Applications are considered, and formulas are given to obtain the necessary information.

Distribution of Normal Component of Induced Velocity in Lateral Plane of a Lifting Rotor. Walter Castles, Jr., and Howard L. Durham, Jr. *U.S., NACA TN 3841,* Dec., 1956. 26 pp. Analysis to determine the values of the nondimen-

MISSILES ENGINEERS...

Let's exchange resumes

NAME:
Douglas Aircraft Company, Inc.

POSITION:
World's largest manufacturer of aircraft and missile systems.

LOCATIONS:
Santa Monica, California
Naval Air Missiles Test Center
Point Mugu, California
Edwards Air Force Base, California
White Sands Proving Grounds
Las Cruces, New Mexico
Air Force Missiles Testing Center
Patrick Air Force Base
Cocoa, Florida
Holloman Air Development Center
Alamogordo, New Mexico

AGE:
15 years in missiles; 37 in aircraft.

EDUCATION:
An engineering company managed by engineers—such as Donald W. Douglas, B.S., Aeronautical Engineering (M.I.T.); F.W. Conant, B.S., Civil Engineering (Cornell); and A. E. Raymond, B.S., Mechanical Engineering (Harvard), M.S., Aeronautical Engineering (M.I.T.), and Ph.D. (Hon.) (Polytechnic Institute of Brooklyn)—and with key staff positions held by graduate engineers, physicists and mathematicians, many with advanced degrees.

EXPERIENCE:
Pioneers in missile research development and production since 1941.
Major contractors for air-to-surface, surface-to-surface, air-to-air and surface-to-air missile systems.
Designers of auxiliary equipment to transport and launch guided missiles.
Establishment of a completely separate missiles division in 1956.
Now responsibile for nine separate missile projects—including such "veterans" as Nike I (1945 to present) and Sparrow (1947 to present).
Extensive flight test experience at proving grounds across the country where Douglas engineers are assigned.
Missiles experience supplemented by 37 years in airframe design, development and manufacture.

REFERENCES:
The U.S. Army, Navy and Air Force.
Thousands of manufacturers of components for missile systems.
Some 1600 Douglas employees now engaged in missile work.

SPARROW I, the Navy's supersonic air-to-air guided missile, intercepts targets even under evasive action.

SERVO AMPLIFIERS used with a four-way electrohydraulic valve being tested by Douglas electronic engineer.

NAME: _____

POSITION: _____

_____

ADDRESS: _____

_____

AGE: _____

EDUCATION: _____

_____

EXPERIENCE: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

REFERENCES: _____

_____

_____

_____

_____

_____

FILL IN THE ABOVE INFORMATION
TEAR OUT THIS RESUME AND SEND TO
C. C. LaVENE
DOUGLAS AIRCRAFT COMPANY
BOX 620-Z
SANTA MONICA, CALIFORNIA

GO FURTHER WITH DOUGLAS FIRST IN AVIATION

sional normal component of induced velocity using the Biot-Savart relation which assumes that the wake vortex distribution consists of a uniform, semi-infinite elliptic cylinder.

Investigation of Vertical Drag and Periodic Airloads Acting on Flat Panels in a Rotor Slipstream. Robert A. Makofski and George F. Menkick. *U.S., NACA TN 3900*, Dec., 1956. 23 pp. Tests to determine the vertical drag and pressure distributions acting on flat panels mounted normal to the rotor slipstream. The panels are tested with semispans of a rotor radius and of one-half a rotor radius at positions from 0.20 to 0.64 of a rotor radius beneath the plane of zero flapping. Calculations of vertical drag by a strip analysis procedure with the assumption of a fully contracted wake agree well with experimental results over the range from 0.20 to 0.64 radius.

Ein neues Drehflügelsystem für höhere Fluggeschwindigkeiten. Hans Derschmidt. *Luftfahrttechnik*, Aug. 15, 1956, pp. 158, 159. In German. Description of a rotor system for higher flight velocities.

Determination of the Structural Damping Coefficients of Six Full-Scale Helicopter Rotor Blades of Different Materials and Methods of Construction. Frederick W. Gibson. *U.S., NACA TN 3862*, Dec., 1956. 19 pp. Investigation to determine structural damping coefficients for the first three flapwise bending modes, the first torsion mode, and the first chordwise bending mode for all blades.

Experimental Investigation on the Langley Helicopter Test Tower of Compressibility Effects on a Rotor Having NACA 63_2-105 Airfoil Sections. James P. Shivers and Paul J. Carpenter. *U.S., NACA TN 3850*, Dec., 1956. 28 pp.

Analytical Determination of the Natural Coupled Frequencies and Mode Shapes and the Response to Oscillating Forcing Functions of Tandem Helicopters. Appendix—**Steps in Reducing the Order of the Matrix Equation.** George W. Brooks and John C. Houbolt. *U.S., NACA TN 3849*, Dec., 1956. 45 pp. Presentation of a method using the Lagrange dynamical equations for free vibrations in conjunction with the kinetic and potential energies of the system in order to obtain the differential equations of motion for the coupled system which are then written in matrix form.

On the Generalized Simple System for Automatic Stabilization of a Helicopter in Hovering Flight. M. A. P. Willmer. *J. Helicopter Assn. Gt. Brit.*, Oct., 1956, pp. 77–102. Analysis of instability on a hovering helicopter with controls fixed. The generalized simple stabilization system, which is composed of rods, springs, dampers, and masses and uses the rotor shaft to generate gyroscopic forces, is studied.

Helicopter Autopilots; Successful Experimental Work Described to the Helicopter Association. *Flight*, Dec. 21, 1956, pp. 957, 958. Theoretical and experimental investigation to develop an automatic law for stabilization purposes. The control system considered has three modes of operation: stabilizing, cruising, and automatic hovering. Results of flight trials on a single-rotor helicopter are presented.

Safety

Proposed Initiating System for Crash-Fire Prevention Systems. Jacob C. Moser and Dugald O. Black. *U.S., NACA TN 3774*, Dec., 1956. 18 pp. Description of an initiating system whose design was dictated by requirements determined from a study of full-scale experimental and accidental airplane-crash data. Includes an example of the application of these requirements in the design of an initiating system for a twin-engined piston-powered airplane.

Beware of Overheated Brakes. *Douglas Serv.*, Nov.-Dec., 1956, pp. 1–7. Discussion and recommendations concerning the use of improper fire-extinguising agents on overheated brakes and wheels.

Impact Measurements on a Large Model of a Representative Landplane Fuselage on Water. Appendix I—**Calculation of Splash-Up.** J. E. Allen. (*Gt. Brit., MAEE Rep. F/Res/264*, Oct., 1954.) *Gt. Brit., ARC CP 283*, 1956. 69 pp. 17 refs. BIS, New York, $1.71.

Space Travel

High Altitude Research. Eric Burgess. *J. Brit. Interplanetary Soc.*, Sept.-Oct., 1956, pp. 261–280. 21 refs. Discussion reviewing the development of appropriate vehicles and the peculiarities connected with rocket experiments in this field, describing types of experiments undertaken and particulars of the instrumentations involved, and explaining data-recovery methods.

Flight Into Space. W. N. Neat. *Spaceflight*, Oct., 1956, pp. 4–6. Discussion of the principle of space flight, taking into account the problem of gravitational force.

Power Sources for Space Flight. S. Fred Singer. *Missiles & Rockets*, Dec., 1956, pp. 82–84. Discussion of various methods for space propulsion which include chemical batteries, a solar battery, a rechargeable fuel-cell battery, nuclear reactor power, and fusion power.

Dynamic Considerations Relating to the Behavior of Inertial Space-Stabilized Platforms. Edmund Gorczycki. (*IAS 24th Annual Meeting, New York, Jan. 23–26, 1956, Preprint 608.*) *J. Aero. Sci.*, Feb., 1957, pp. 130–138.

Chemistry in Space Flight. I—The Use of Cobaltous Bis Salicylidene Ethylenediamine in Planetary Exploration. Wayne Proell. *J. Space Flight*, Nov., 1956, pp. 1–5.

The Effect of Meteoric Particles on a Satellite. S. F. Singer. (*ARS Semi-Annual Meeting, Cleveland, June 18–20, 1956.*) *Jet Propulsion*, Dec., 1956, pp. 1,071–1,075, 1,087, 1,090. 20 refs. Analysis of some physical models to allow calculation of the erosion rate on space vehicles. These studies lead to widely differing values, and it is concluded that laboratory experiments with artificially accelerated dust particles would furnish more reliable guides for a theory.

Navigation in Interplanetary Space. Peter Castruccio. *Missiles & Rockets*, Dec., 1956, pp. 98, 99, 101. Discussion of three systems of space navigation: (1) beams aimed between planets, forming polygons of variable legs, each of which always represents the shortest distance between planets; (2) very broad beams, or omnidirectional radiators, placed on the planet of destination; and (3) space Loran or an analogous system.

The Vanguard Project. Kenneth W. Gatland. *Spaceflight*, Oct., 1956, pp. 15–28. 20 refs. Discussion of the vehicle design and launching and tracking problems, with a review of rocket development.

The Artificial Earth Satellite—Past, Present and Future. S. F. Singer. *Interavia*, Dec., 1956, pp. 956–959. Discussion of the scientific research significance of the artificial satellite program, with emphasis on weather control.

The I.G.Y. Rocket and Satellite Program. Joseph Kaplan. *Interavia*, Dec., 1956, pp. 953–955. Discussion of the IGY program giving details of the scientific objectives, the responsibilities of the agencies involved in the program, the launching procedures, and the methods of tracking.

Instrumental Satellites and Instrumental Comets. Krafft A. Ehricke. *Interavia*, Dec., 1956, pp. 960–962. Discussion of future developments in satellites and their scientific applications. This discussion includes flight performances, flight accuracy, tracking, and data transmission.

The Baker-Nunn Satellite-Tracking Camera. Karl G. Henize. *Sky & Telescope*, Jan., 1957, pp. 108–111. Description of an optical system to track and continually photograph an earth satellite.

Structures

A Simple Method of Matric Structural Analysis. Bertram Klein. *J. Aero. Sci.*, Jan., 1957, pp. 39–46. 51 refs. Derivation of a procedure from the analysis of certain semimonocoque structures under the assumption of uniformly composed (untapered) structural elements, some taking only axial loads and others only shear loads in the form of constant shear flows (except for triangular panels). Includes application of the method to certain two- and three-dimensional problems.

Crack Propagation Tests Safeguard New Lockheed Structures. W. J. Conway. *Av. Age*, Dec., 1956, pp. 32, 33, 34–39 ff. Data from static-loading crack-propagation tests, some of which were run in preparation for the Electra turboprop transport, giving criteria for the achievement of fail-safe structures.

On the Kinetics of the Growth of Cracks During the Breaking of Solids. V. R. Regel. *Soviet Physics - Tech. Phys.*, No. 2, 1956, pp. 353–361. Translation. Experimental investigation of surface and penetrating cracks in samples of polymethylmethacrylate with different amounts of plasticizer.

Fatigue Cracks as Stress Raisers and Their Response to Cyclic Loading. C. E. Phillips. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 104–125. 13 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

A Visit to Some American Research Establishments Engaged on Fundamental Fatigue Work. P. J. E. Forsyth. *Gt. Brit., RAE TN Met.245*, July, 1956. 10 pp. 25 refs.

to the Engineer who seeks a wide variety of assignments

To non-aircraft engineers:

Aircraft experience is not necessary to join Lockheed. It's your engineering training and experience that count. Lockheed trains you for aircraft engineering—at full pay.

An unparalleled variety of assignments awaits you at Lockheed's Engineering Flight Test Division.

Lockheed diversification is the reason. This year alone flight tests must be conducted on new turbo-compound and prop-jet transports, extremely high-speed fighters, new types of jet trainers, patrol bombers, radar search planes and aerological aircraft. In development are jet transports and nuclear applications to aircraft and a large number of classified aircraft.

You not only work on many types of aircraft in Lockheed Flight Test, your work within each plane varies widely. Each flight test presents new problems, frequently requires new approaches.

Because of this, personal initiative is welcomed and rewarded at Lockheed.

Assignments are in fields of:

POWER PLANT: engine and after-burner; fuel systems; oil, fire extinguishing and air conditioning systems.

FLIGHT ANALYSIS: CAA certification, aerodynamic performance, data processing.

STRUCTURAL FLIGHT MEASUREMENT

INSTRUMENTATION: systems design, calibration and maintenance.

WEAPONS: fire control systems, ordnance, rocket sleds.

RADIO AND RADAR: communications, search radar, magnetometers ranging and sighting gear.

DYNAMICS: flutter, sound, vibration, autopilot and approach systems.

Positions are open for:

AERONAUTICAL ENGINEERS
MECHANICAL ENGINEERS
ELECTRICAL ENGINEERS
PHYSICISTS
ELECTRONIC ENGINEERS
CIVIL ENGINEERS
with and without aircraft experience
AIR TRANSPORT OPERATIONS ENGINEERS

Brief résumé form at right is for your convenience in contacting Lockheed.

E. W. Des Lauriers, Dept. 0503
Lockheed Aircraft Corporation
Burbank, California

California Division

Lockheed

Lockheed Aircraft Corporation
Burbank **California**

Name

Field of engineering

Home Address

Home Phone

Where employed

OPPORTUNITIES FOR

Metallurgists, Ceramic Engineers
Welding Engineers
Materials Test Engineers

An example of Marquardt's progress and challenge is this new test instrument—designed and built by Marquardt Aircraft Co. engineers. The only one in existence, it was created to provide information on short time elevated temperature properties of materials utilized in supersonic missiles and powerplants.

Engineers are needed to conduct development programs aimed at establishing design and manufacturing criteria for the application of metals to ramjet engines. These programs cover a wide variety of structural materials and many different manufacturing processes.

Included are such diversified programs as:

1 The evaluation of new alloys from aluminum to molybdenum.

2 The development and evaluation of new manufacturing techniques from welding and forming to the application of ceramic coatings and high temperature brazing.

3 Investigations of the physical and mechanical properties of materials at temperatures from −350°F to +3000°F for service lives ranging from seconds to hours.

4 Support of the design and fabrication of experimental ramjet engines.

Requirements exist for personnel at all levels of training and experience. Bachelors—or advanced degrees in engineering are required.

Now is the time to write *that* letter, or call
John Murray, Professional Personnel
16555 Saticoy • Van Nuys, Calif. • STate 5-8361

marquardt AIRCRAFT CO.

FIRST IN RAMJETS
Van Nuys, California • Ogden, Utah

Aircraft Structural Fatigue Research in Australia. W. W. Johnstone and A. O. Payne. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 427–448. 47 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Australian Work on Aircraft Fatigue and Life Evaluation; A Historical Review of Australian Research in Structural Fatigue and Life Assessment of Aircraft. F. H. Hooke and P. S. Langford. *Aircraft Eng.*, Dec., 1956, pp. 408–414. 15 refs.

Some Remarks on the French Approach to the Problem of Fatigue. J. Cornillon. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 317–322. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Fatigue des Structures d'Avions. II—Endommagement par Fatigue et Rupture des Pièces Entaillées. W. Barrois. *Docaéro*, Nov., 1956, pp. 9–22. 32 refs. In French. Study of the problem of fatigue in aircraft structures.

Practical Aspects of Fatigue in Aircraft Structures. R. L. Schleicher. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 376–426. 12 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Structural Fatigue Research and Its Relation to Design. P. D. Brooks. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 207–232. 11 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Scatter of Fatigue Life and Fatigue Strength in Aircraft Structural Materials and Parts. W. Weibull. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 126–145. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Accumulation of Fatigue Damage. A. M. Freudenthal and R. A. Heller. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 146–177. 14 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

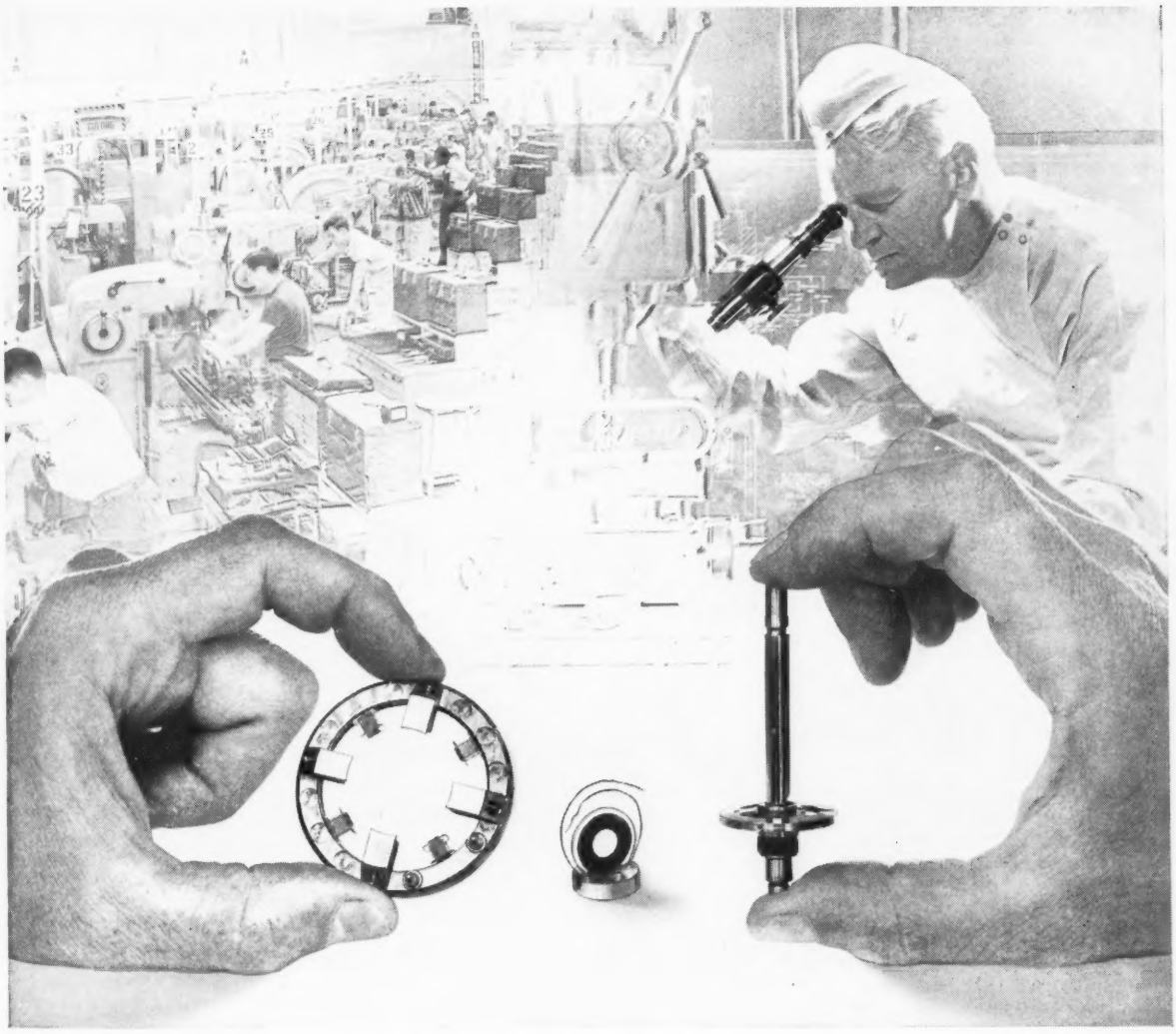
The Elements of a Helicopter Fatigue Substantiation Program. H. T. Jensen. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31, 1956*, pp. 233–254. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Fatigue Testing in Relation to Transport Aircraft. R. J. Atkinson. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 279–294. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Fatigue Engineering in Aircraft. Paul Kuhn. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 295–316. 26 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

Aspects of Fatigue Design of Aircraft Structures. F. Turner. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 323–346. 17 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

The Extent of the Fatigue Problem in Aircraft Design. H. Giddings. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1,*



Autonetics brings laboratory precision to the production line

...with special tools and techniques

Side by side with its achievements in electro-mechanical *engineering*, AUTONETICS has developed laboratory-perfect *manufacturing* skills and equipment to turn intricate designs into complete guidance and control systems ... *in quantity*.

This unique production capability embraces almost every phase of advanced electro-mechanical technology. Precision machine shops—among the most complete in the country—contain special tools which have millionth-of-an-inch capabilities. Electronics production extends into the furthermost areas of microminiaturization, etched-transistorized circuitry and computer fabrication.

In fabrication and assembly of high precision equipment, AUTONETICS has reduced to a production science what was formerly regarded as work for the artisan.

To assure consistent compliance with rigid military specifications, AUTONETICS has developed extensive check-out equipment—ranging from completely automatic electronic test systems to specialized electro-hydraulic testing facilities.

With a wide variety of skilled engineers, manufacturing and supporting personnel, and modern facilities, AUTONETICS is one of the few companies in the world today with full capability in the design and quantity manufacture of inertial navigation, flight control and armament control systems, computers and other complete systems for the military and industry.

For detailed information—or for employment in this dynamic field—write: AUTONETICS, Dept. AER-72, 12214 Lakewood Blvd., Downey, California.

Autonetics

A DIVISION OF NORTH AMERICAN AVIATION, INC.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

1956, pp. 347–375. (New York, Academic Press Inc., 1956, $12. 456 pp.)

The Relationship Between Load Spectra and Fatigue Life. Bo Lundberg and Sigge Eggwertz. *Internatl. Conf. on Fatigue in Aircraft Structures, Proc., Columbia U., Jan. 30, 31–Feb. 1, 1956*, pp. 255–278. 24 refs. (New York, Academic Press Inc., 1956, $12. 456 pp.)

An Experimental Study of the Response of Simple Panels to Intense Acoustic Loading. Leslie W. Lassiter, Robert W. Hess, and Harvey H. Hubbard. (*IAS 24th Annual Meeting, New York, Jan. 23–26, 1956, Preprint 632.*) *J. Aero Sci.*, Jan., 1957, pp. 19–24, 80.

Total Creep Under Varying Loads. William Prager. *J. Aero. Sci.*, Feb., 1957, pp. 153–155. Analysis showing that, under certain conditions, only a single nonlinear boundary-value problem must be solved in order to determine the total creep.

On the Stresses in a Strip Under Tension and Containing Two Equal Circular Holes Placed Longitudinally. A. Atsumi. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec. 1956, pp. 555–562.

Behavior of Materials Under Combined Stresses in Pressurized Structures. A. D. Topping. *Aero. Eng. Rev.*, Feb., 1957, pp. 56–59. 16 refs. Discussion of the design of pressurized cabins in which the phenomenon of brittleness due to the presence of hydrostatic tension is encountered.

Note on the Boundary Conditions for Bending Experiments with Bars and Plates. W. H. Hoppmann, II, and W. G. Soper. *J. Appl. Mech.*, Dec., 1956, pp. 646, 647. ONR-supported research.

Calcul des Dimensions des Boulons par Rapport à une Compression Autorisée sur le Bois (Avec des Conditions Limites Adoptées des Appuis Encastrés). Mirko Yossifovitch. *Tech. et Sci. Aéronautiques*, No. 5, 1956, pp. 239–246. In French. Calculation of bolt size in relation to a compression limit set by wood aircraft structures.

Minimum Weight Design of Cylindrical Shells. Walter Freiberger. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 576–580. Development of a method for designing the variable wall thickness of a cylindrical shell under axial loading and arbitrary pressures to give maximum economy of material. Analysis is based on Onat and Prager's theory of collapse and minimum weight design of cylindrical shells, and the resulting design is such that the shell does not fail plastically in the sense used in limit analysis. The shell is assumed to be supported at the ends by inextensible rings so that the circumferential strain rates vanish there.

Beams & Columns

Stresses in Single-Span Deep Beams. F. E. Archer and E. M. Kitchen. *Australian J. Appl. Sci.*, Dec., 1956, pp. 314–326. Determination of the stress distribution in beams having a rectangular cross section in which the thickness is small compared with the depth. Strain-energy methods are used.

Finite Fourier Transform Analysis of the Flexure of a Non-Uniform Beam. E. E. Jones. *J. RAeS*, Dec., 1956, pp. 805, 806. Extension of Strandhagen's method for investigating a uniform beam to the case of a nonuniform beam whose deflection appears in the form of a Fourier series. The coefficients of this series are functions of the loading, of the end conditions, and of parameters which define the nonuniform flexural rigidity of the beam.

A Method for Determining the Flexural Effects of Statically Loaded Beams on Multiple Elastic Supports. R. A. Di Taranto. (*ASME Natl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 503–508.

The Effect of Shear on the Plastic Bending of Beams. D. C. Drucker. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 509–514. Theoretical investigation of cantilever and simple rectangular beams in order to derive a useful interaction curve and to clarify the reasons for the lack of a unique curve.

Impulsive Loading of Elastic-Plastic Beams. J. A. Seiler, B. A. Cotter, and P. S. Symonds. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 515–521. Theoretical investigation of a simply supported uniform beam of ductile material, subjected to impulsive loading such that the initial velocity is a half-sine wave, in order to provide information for estimating the range of validity of the rigid-plastic type of analysis.

An Experimental Investigation of Beam Stresses Produced by Oblique Impact of a Steel Sphere. D. M. Cunningham and Werner Goldsmith. (*ASME West Coast Conf., Appl. Mech. Div., Pasadena, June 11–13, 1956.*) *J. Appl. Mech.*, Dec., 1956, pp. 606–611. Navy-supported research.

Column Design. Albert L. Gosman, Frank R. Campbell, and Richard P. Bobco. *Mach. Des.*, Dec. 13, 1956, pp. 137–139. Analysis resulting in a chart which enables the designer to locate the transition points between the Euler-Johnson expressions for a variety of materials and end-fixity conditions.

The Mathematical Analysis of Bow Girders of Any Shape. M. M. Abbassi. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 522–526. Derivation of exact and approximate formulas for symmetrical bow girders of any shape carrying a distributed load or two equal concentrated loads placed symmetrically with respect to the middle point of the girder.

Cylinders & Shells

Three-Dimensional and Shell-Theory Analysis of Axially Symmetric Motions of Cylinders. George Herrmann and I. Mirsky. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 563–568. 25 refs.

Effect of Imperfections on Buckling of Thin Cylinders Under External Pressure. L. H. Donnell. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 569–575. Analysis using finite-deflection theory and the same imperfection assumptions as were used in Donnell and Wan's investigation of buckling under axial compression.

The Influence of Blast Characteristics on the Final Deformation of Circular Cylindrical Shells. P. G. Hodge, Jr. (*ASME West Coast Conf., Appl. Mech. Div., Pasadena, June 11–13, 1956.*) *J. Appl. Mech.*, Dec., 1956, pp. 617–624. ONR-supported theoretical investigation resulting in the development of a straightforward graphical-numerical method of solving the double quadrature of pressure in which the maximum deformation is expressed where the limits of integration are determined from the side conditions.

Donnell's Equation for Thin Shells. Herbert Becker. *J. Aero. Sci.*, Jan., 1957, pp. 79, 80. Application of Donnell's equation to determine an expression for the buckling stress of a sphere under uniform external pressure.

Tables and Curves for Deformations and Stresses in Circular Cylindrical Shells Under Localized Loadings. Joseph Kempner, James Sheng, and Frederick V. Pohle. *J. Aero. Sci.*, Feb., 1957, pp. 119–129. 16 refs. OOR-supported presentation including description of procedures which facilitate application of data to cylinders under arbitrary radial surface loads.

Axisymmetrical Buckling of Circular Cones Under Axial Compression. Paul Seide. (*ASME West Coast Conf., Appl. Mech. Div., Pasadena, June 11–13, 1956.*) *J. Appl. Mech.*, Dec., 1956, pp. 625–628. Theoretical investigation to derive a simple expression for long cones of constant thickness, relating the cone buckling load to the buckling load of a long cylinder of equal thickness and the cone semivertex angle.

Torsional Buckling of Moderate-Length Cylinders. Herbert Becker and George Gerard. *J. Appl. Mech.*, Dec., 1956, pp. 647, 648.

The Buckling of Spherical Shells by External Pressure. IV. Masuji Uemura. *J. Japan Soc. Aero. Eng.*, Nov., 1956, pp. 1–8. Analysis of two buckling problems (excluding the case of dead weight loading where the external pressure remains constant during the buckling process) by means of energy considerations.

On Obtaining the Shear Stress-Strain Relationship from a Hollow Specimen in Torsion. J. P. Ellington. *J. RAeS*, Dec., 1956, pp. 806–808.

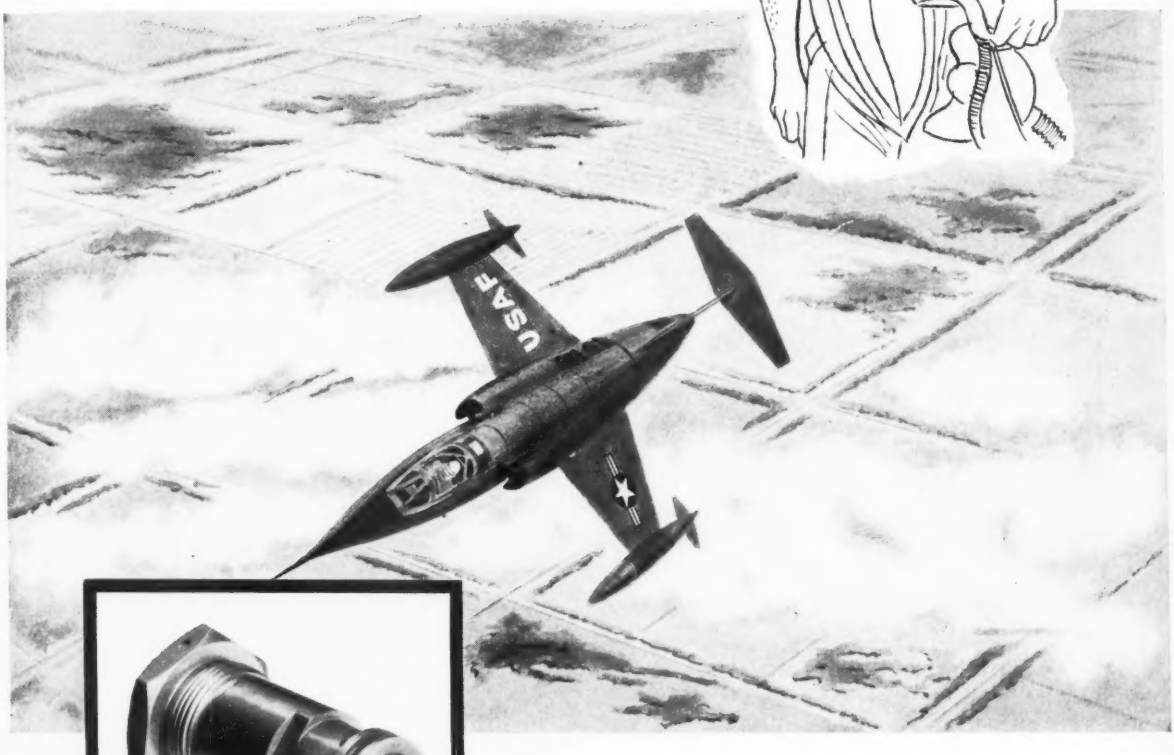
On the Calculation of Shallow Shells. S. A. Ambartsumyan. (*Prikl. Mat. i Mekh.*, Vol. XI, 1947.) *U.S., NACA TM 1425*, Dec., 1956. 11 pp. Translation. Analysis of the problem of a uniform and concentrated loading on a shell bounded by a coordinate rectangle, using Vlasov's theory of shells.

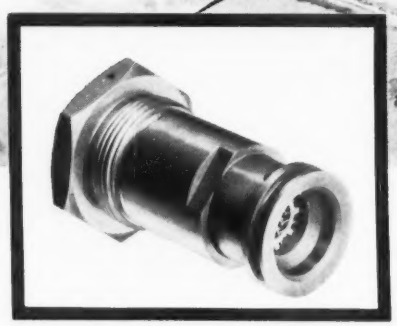
On the Theory of Anisotropic Shallow Shells. S. A. Ambartsumyan. (*Prikl. Mat. i Mekh.*, Vol. XII, 1948.) *U.S., NACA TM 1424*, Dec., 1956. 11 pp. Translation. Development of simultaneous equations for both the stress and deflection function of an anisotropic shallow shell.

Elasticity & Plasticity

On the Transmission of a Concentrated Load Into the Interior of an Elastic Body. G. L. Neidhardt and Eli Sternberg.

Because HIS LIFE *depends on it...*





. . . Nothing is left undone to make the Relief Valve in the fuel pump, the Safest, the most Dependable, the Lightest valve possible with today's skills and materials.

Fluid Regulators Corp. is a Major Designer and Producer of Relief Valves for jet fuel pumps.

Designers and Producers of Aircraft Hydraulic and Fuel Valves.

Fluid Regulators
CORPORATION
313 GILLETTE STREET • PAINESVILLE, OHIO

Mechanical Engineers are putting Electrons to Work at RCA

...and now, mechanical engineers can help create RCA's advanced airborne weapons systems

Mechanical engineers are particularly essential in this field, for desired performance characteristics are running into barriers of mechanical limitations. The men who can qualify will create the muscles and sinew that change electrical impulses into more powerful weapons forces...such as airborne fire control systems or airborne communications. It will take real engineering ingenuity to develop reliable mechanical equipment of the lightest weight to fit in the smallest space and function in extremes of environmental shock, vibration, cooling, humidity and altitude.

Today, RCA has openings of interest for mechanical engineers with experience in:

Vibration and stress analysis
Electronic thermal design
Precision mechanism design
Electronic and hydraulic servo application
Printed circuitry and transistor packaging
Electronic equipment packaging
Aircraft installation and structures design
Environmental testing

Positions for both Junior and Senior Engineers . . . excellent opportunities for professional advancement . . . liberal benefits . . . Tuition Refund Plan for advanced education.

To arrange personal interview, send resume to:

Mr. Robert A. Wallace
Engineering Personnel, Dept. Z-14C
Radio Corporation of America
Bldg. 10-1, Camden 2, N.J.

World Leader in Electronics
RADIO CORPORATION of AMERICA
Defense Electronic Products

(*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 541–554. 22 refs. Derivation of an exact solution in series form for the stresses and displacements in an elastic body bounded by one sheet of a two-sheeted hyperboloid of revolution, subjected to an axial concentrated load at the vertex. Numerical results found for the normal stress on planes perpendicular to the axis of symmetry, at points on this axis, provide the basis for a discussion of the influence of the curvature of the boundary at the load point upon the transmission of the load into the interior of the body.

Three "Neutral" Loading Tests. S. S. Gill. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 497–502. Experimental investigation using hollow tubes of alpha brass subjected to combined torsion and internal pressure to measure shear, axial, and circumferential strain. The resulting plastic-strain increment vectors are plotted to illustrate their direction relative to the loading path.

A New Method of Analyzing Stresses and Strains in Work-Hardening Plastic Solids. William Prager. (*ASME Natl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 493–496. ONR-supported study.

Plates

Boundary-Value Problems of Simply-Supported Elastic Plates. T. Buchwald and R. Tiffen. *Quart. J. Mech. & Appl. Math.*, Dec., 1956, pp. 489–498.

The Buckling of Tapered Plates in Compression. Bertram Klein. *Aircraft Eng.*, Dec., 1956, pp. 427–430. Development of a simple matric formulation for calculating the elastic buckling of a class of simply supported flat plates that are simultaneously tapered in plan form and thickness, and are subjected to biaxial loading in each direction.

Photoelastic Investigation on Plates with Single Interference-Fit Pins with Load Applied to Plate Only. H. T. Jessop, C. Snell, and G. S. Holister. *Aero. Quart.*, Nov., 1956, pp. 297–314.

Analysis of a Loaded Cantilever Plate by Finite Difference Methods. Appendix I—**Computation Molecules.** Appendix II—**The Elimination of Fictitious Displacement from the Basic Difference Patterns.** Appendix III—**The Influence Matrix for a Square Cantilever Plate with $\nu = 0.3$.** Appendix IV—**The Influence Coefficients for a Square Cantilever Plate with a Unit Corner Load.** R. K. Livesley and P. C. Birchall. *Gt. Brit., RAE TN M.S.26*, June, 1956. 24 pp.

Berechnung von teilweise eingespannten rechteckigen Platten bei Vorgabe von Randmomenten. Udo Wegner. *ZAMM*, Sept.-Oct., 1956, pp. 340–355. In German. Analysis of an incomplete, coorthogonal, complex system of biharmonic functions.

The Design of Intermediate Vertical Stiffeners on Web Plates Subjected to Shear. K. C. Rockey. *Aero. Quart.*, Nov., 1956, pp. 275–296. 25 refs. Experimental investigation on stiffened web plates to obtain relationships between the size and spacing of vertical stiffeners, and

the buckling stress of the stiffened web plate when it is subject to shear.

A Lower-Bound Solution to the Buckling Stress of Uniformly Clamped Parallelogram Plates. J. Guest. *Australian J. Appl. Sci.*, Dec., 1956, pp. 336–345. Extension of the Budiansky approach to calculate the lower limits of the critical compressive stress by using the Lagrangian multiplier method.

Sandwich Structures

New Steel Honeycombs Are All-Welded. *Av. Age*, Dec., 1956, pp. 52, 53, 54, 55 ff.

Influence of Through Metal on Heat Transfer Through Aircraft-Structural-Sandwich Panels. J. R. Woolf and L. R. Scott. *ASME Semi-Annual Meeting, Cleveland, June 17–21, 1956, Paper 56-SA-23.* 16 pp. Theoretical and experimental investigation for the overall conductance of a sandwich panel having internal through metal slugs with metal skins of the same thickness on both sides.

Testing

A Photoelastic Method Employing Scattered Light for the Solution of Plane Stress Problems. W. Shelson and I. W. Smith. *Brit. J. Appl. Phys.*, Dec., 1956, pp. 436–439. Description of a method based on the combined use of three retardation fringe patterns—a standard isochromatic pattern and two perpendicular scattered-light patterns.

Experimental Stress Analysis in the U.S.A. and Canada. A. F. C. Brown. *Gt. Brit., DSIR OTR 1*, 1956. 22 pp. 107 refs. Survey of existing methods in experimental stress analysis and of some new applications. Discussion includes electrical resistance strain gages, photoelasticity, brittle coatings, analogy methods, and high-temperature effects in aircraft structures.

Thermal Stress

Thermal Stresses in Infinite Elastic Disks. Brahmadev Sharma. (*ASME Natl. Appl. Mech. Div. Conf., Urbana, June 14–16, 1956, Paper.*) *J. Appl. Mech.*, Dec., 1956, pp. 527–531. Direct analytical method for solving thermal stresses, due to any temperature distribution, in infinite elastic discs. Discussion of the steady state leads to solutions for a disc of finite thickness and infinite radius whose stresses are attributable to axisymmetric temperature distribution, and for a semi-infinite solid in which the elastic properties change at a depth *d*.

Temperature and Diffusion Near Slip Bands During Fatigue. Appendix I—**Experimental Observations of Increased Diffusion During Straining.** Appendix II—**Heat Flow Problems.** N. J. Wadsworth. *Gt. Brit., RAE TN Met.251*, Aug., 1956. 21 pp. 30 refs. Discussion of the average and instantaneous temperatures which can occur in slip bands during fatigue tests. It is shown that the mean temperature of the slip band is not appreciably above that of the surrounding material.

Effect of Thermal Resistance of Joints Upon Thermal Stresses. B. E. Gatewood. *J. Aero. Sci.*, Feb. 1957, pp. 152, 153.

The Calculation of Thermoelastic Beam Deflections by the Principle of Virtual Work. Bruno A. Boley. *J. Aero. Sci.*, Feb., 1957, pp. 139–141. USAF-sponsored study of an appropriate approximate formula, to assess its accuracy from the standpoint of a more rigorous thermoelastic solution.

Transient Thermal Stress in a Flat Plate Due to Non-Uniform Heat Transfer Across One Surface. N. S. Heaps. (*Gt. Brit., RAE Rep. Struc.164*, Apr., 1954.) *Gt. Brit., ARC CP 299*, 1956. 27 pp. 14 refs. BIS, New York, $0.72.

Transient Temperature Distributions and Thermal Stresses in Fuselage Shells with Bulkheads or Frames. J. S. Przemieniecki. *J. RAeS*, Dec., 1956, pp. 799–804. Theoretical investigation to simplify and generalize the analysis of the aerodynamic heating problem in fuselage structures, in order to clarify the salient features and to suggest methods to overcome adverse thermal effects.

Zur numerischen Bestimmung der Wärmespannungen. W. Bader. *ZAMM*, Sept.-Oct., 1956, pp. 331–339. 12 refs. In German. Determination of particular solutions for the Poisson equation of the displacement potential, and development of a method of solution for the displacement field that is to be superposed in order to fulfill the surface conditions.

Wings

A Programme for Low Aspect Ratio Wing Analysis. J. P. Morton. *Aircraft Eng.*, Dec., 1956, pp. 415–418. Development of a digital-computer program based on Schuerch's method to study the effect of variation in structural design and to provide reasonable data for preliminary stressing.

Random and Programmed Load Sequence Fatigue Tests on 24ST Aluminium Alloy Wings. A. O. Payne. *Australia, ARL Rep. SM.244*, Sept., 1956. 34 pp. Experimental investigation of the fatigue behavior of Mustang wings under repeated loading (i.e., cycling at constant amplitude) and under a random sequence of loads designed to represent the flight-load history of a transport aircraft.

Determination of Influence Coefficients. S. Levy. (*Structures & Materials Panel, 3rd Meeting, Washington, Apr. 10–17, 1956.*) *NATO AGARD Rep. 41*, Feb., 1956. 5 pp. Comparison of three different methods for determining the influence coefficients for delta wings. These include the strain-energy, consistent-deformation, and differential-equation methods.

Measured Strains in a Swept Tapered Tube. II. G. L. Belcher. *Australia, ARL Rep. SM.242*, July, 1956. 28 pp. Experimental investigation to determine the stresses and strains for the cover (near the tube's root) and for the spar webs of a tube of rectangular cross section with the ribs parallel to the line of flight.

Thermodynamics

Thermodynamic Properties of Air at High Temperatures. R. L. Dommett. *Gt. Brit., RAE TN G.W.429*, Aug., 1956. 39 pp. 51 refs. Derivation of values for the thermodynamic and transport properties of air both undissociated and in dissociation equilibrium for temperatures up to 12,000°K.

Intermolecular Forces and Equation of State of Gases. IV—Phase Transition in a System of Repulsion. Taro Kihara. *U. Wis. NRL Dept. Chem. TR WIS-AF-6 (Ser. 10.)*, Dec. 11, 1956. 12 pp.

Combustion

Non-Stationary Surface Combustion Studies (Fifth Quarterly Technical Status Report). D. Bitondo, N. Thomas, and D. Perper. *ADC Rep. ADC-51*, Dec. 26, 1956. 10 pp. Discussion of the progress made in the determination of "bulk" ignition delay time and in the development of a timing device to measure the velocity of a shock wave.

The Slow Combustion of Methyl Alcohol—A General Investigation. K. M. Bell and C. F. H. Tipper. *Proc. Royal Soc. (London), Ser. A*, Dec. 18, 1956, pp. 256–268. 21 refs. Inquiry over a temperature range between 430° and 470°C. and at pressures below atmospheric, using pressure-time curves to study the kinetics of the reaction. A reaction scheme is proposed which explains the kinetic and analytical results.

Cool Flames in the Combustion of Toluene and Ethylbenzene. R. G. W. Norrish and G. W. Taylor. *Proc. Royal Soc (London), Ser. A*, Dec. 18, 1956, pp. 143–153. 14 refs. Experimental investigation of the oxidation of toluene and ethylbenzene in a static system using a spherical reaction vessel (700 ml.) over the temperature range 300° to 500°C., and at total pressures up to 600 mm. Includes comparison of results with corresponding data for the oxidation of paraffin hydrocarbons.

Effect of Concentration on Ignition Delays for Various Fuel-Oxygen-Nitrogen Mixtures at Elevated Temperatures. E. Anagnostou, R. S. Brokaw, and J. N. Butler. *U.S., NACA TN 3887*, Dec., 1956. 34 pp. Investigation of ignition delay for mixtures of ethane, n-butane, isobutane, hydrogen, or propane with oxygen and nitrogen, using a flow system with two experimental procedures.

An Analogue for High-Intensity Steady-Flow Combustion Phenomena. D. B. Spalding. *Chartered Mech. Engr.*, Dec., 1956, pp. 516, 517. Development of an electric analog to make possible faster testing in the early stages of combustion chamber design.

A Thermal Equation for Flame Quenching. A. E. Potter, Jr., and A. L. Berlad. *U.S., NACA Rep. 1264*, 1956. 7 pp. Supt. of Doc., Wash, $0.15. Extension of the Simon-Belles-Spakowski quenching-distance equation to include hydrocarbon-rich mixtures.

The ηq Meter, a Rapid Instrumental Method of Combustion Gas Analysis. F. H. Holderness. *Gt. Brit., NGTE Rep. R.194*, Nov., 1956. 52 pp. Description of the operating principles of an apparatus for gas analysis. An analysis can be completed in 6 to 10 min. by using a sample taken directly from a combustion chamber.

Heat Transfer

Heat Transfer Between Solid Particles and Gas in a Rocket Nozzle. Peter L. P.

Dillon and Lloyd E. Line, Jr. *Jet Propulsion*, Dec., 1956, pp. 1,091–1,097, 1,090. Method for calculating the degree of heat transfer, assuming that the system is one in which the solid particles are no larger than the mean free path of the gas carrying them. It is further assumed that the particles are in directed velocity equilibrium with the gases.

Investigation of Transient Pool Boiling Due to Sudden Large Power Surge. Appendix A, B—**Temperature Distribution Along Length of Ribbon.** Appendix C—**Simplified Derivation of Ribbon Temperature.** Appendix D—**Temperature Distribution Through Ribbon Into an Infinite Medium.** Appendix E—**Average Ribbon Temperature.** Robert Cole. *U.S., NACA TN 3885*, Dec., 1956. 44 pp.

Production of High-Temperature, Moderate-Pressure Gases by Means of Electrical Spark Discharge. Appendix A—**Thermodynamics of Real Gases, Air and Helium.** Appendix B—**Circuit Theory.** Daniel E. Bloxsom. *USAF AEDC TN 56-17 [AD 98980]*, Nov., 1956. 39 pp. Investigation to determine the nature of high-pressure heating by spark discharge. Experiments were conducted by discharging high-energy-level sparks in air, argon, and helium under constant volume conditions.

The Influence of Radiative Transfer on Cellular Convection. R. M. Goody. *J. Fluid Mech.*, Oct., 1956, pp. 424–435. Approximate solution for the problem of the onset of convection between plane-parallel plates heated from below when the fluid between them absorbs and emits thermal radiation.

Die Bestimmung schnell wechselnder Temperaturen und des Wärmeübergangs von einem Gas an einen metallischen Körper. *VDI Zeitschrift*, Dec., 1956, pp. 1,925, 1,926. In German. Determination of transient temperatures and heat transfer at a gas-metal interface.

The Air-Gap Thermal Resistance of an Electrical Machine. J. Hak. (*Arch. für Elektrotech.*, No. 5, 1956, pp. 257–272.) *Gt. Brit., RAE Lib. Transl. 589*, Sept., 1956. 21 pp. Study of the air gap in electrical machines by regarding the gap as an air layer between two coaxial cylinders. It is shown that the flow is turbulent in most cases. Based on the assumptions of turbulent heat conductivity and viscosity, the velocity and temperature distributions in the air gap are determined. The friction factors and heat-transfer coefficients for both walls are also calculated.

Calcul Numérique; Calcul Physique; Application à la Thermocinétique. Pierre Vernotte. *France, Min. de l'Air PST 319*, 1956. 344 pp. SDIT, 2, Av. Porte-d'Issy, Paris 15, Frs. 2,200. In French. Review of the fundamental aspects of thermokinetic phenomena and development of methods for solving the derived equations and for summarizing the resulting very-slow series. Methods of data analysis are also presented.

Problemas de Transmisión de Calor en Motores Cohete. H. Ziebland. *Rev. Asoc. Argent. Interplan.*, July-Sept., 1956, pp. 9–21. In Spanish. Study of the problem of heat transfer in rocket engines.

VTOL & STOL

Flight-Test Instrumentation for Vertical Take-Off Aircraft. E. R. Hinz and R. A. Fuhrman. (*NATO AGARD Meeting, Brussels, Aug. 27–31, 1956.*) *Aero. Eng. Rev.*, Feb., 1957, pp. 75–81. Discussion of possible solutions to some VTOL instrumentation problems, particularly those involved in attitude and velocity measurement, in the light of the three VTOL flight regimes: hovering, transition, and conventional.

The Ramprop, a Supersonic Jet Driven Propeller. Albert Gail. *ZFW*, Nov., 1956, pp. 341–355. Theoretical investigation of the pertinent structural and aerodynamic problems and proposal of an appropriate design for this propulsion system which consists of rotor blades driven with supersonic speed by ramjets or ramrockets at the blade tips.

Short SC.1: Britain's Unique V.T.O. Research Aircraft. *Flight*, Dec. 21, 1956, p. 949. Description of design characteristics for a delta-winged VTO aircraft powered by a unique arrangement of five Rolls-Royce R.B.108 turbojets, and having stabilizing air jets mounted in the wings and fuselage.

Wind Tunnels & Research Facilities

Water Tunnel Boundary Effects on Axially Symmetric Fully Developed Cavities. I. J. Campbell and G. E. Thomas. *Gt. Brit., ARC CP 278*, 1956. 25 pp. 10 refs. BIS, New York, $0.72.

Caractéristiques et Possibilités du Centre d'Essais de l'O.N.E.R.A. à Modane-Avrieux (France). Maurice Roy. *France, ONERA Pub. 85*, 1956. 23 pp. In French. Description of the location, instrumentation, and operation of the ONERA research facility at Modane-Avrieux.

Arnold Engineering Development Center. John M. Wild. (*ASME Semi-Annual Meeting, Cleveland, June 17–21, 1956, Paper 56-SA-71.*) *Mech. Eng.*, Jan., 1957, pp. 8–12. Discussion giving the description, performance, and operation of technical facilities at the AEDC research center. These include the engine test facility with its ram-jet addition and the propulsion wind tunnel.

Automatic Indicating and Recording Data Systems for Wind Tunnels. J. B. D'Andrea. (*NATO AGARD 8th Wind Tunnel & Model Testing Panel, Rome, Feb. 20–25, 1956.*) *NATO AGARD Rep. 16*, Feb., 1956. 39 pp. Application of a shaft analog-to-digital converter unit and a signal-damping device to an automatic data-recording system.

Method of Calculation for Heat-Regenerators of Blowdown Windtunnels. E. Van Spiegel. *Netherlands, NLL TM F.190*, Aug. 13, 1956. 14 pp. Calculation of the temperature distributions in a heat regenerator with flat steel plates for the case where the inlet temperature of the air decreases adiabatically.

Messung kleiner Luftgeschwindigkeiten in stark verwirbelten Strömungen. *VDI Zeitschrift*, Nov. 21, 1956, p. 1,836. In German. Description of technique and instrumentation for low-speed measurement of turbulent flows occurring in wind tunnels.

Gas Turbine Drive System for Wind Tunnels Requiring Extremely High Power. Hans von Ohain. *USAF WADC TN 55-319 (OTS, PB 121488*, $0.50), July, 1956. 10 pp. Study of the feasibility of a gas-turbine drive system for a power output of the order of 1 million hp. It is found that the development risk, time, and cost of such a drive system can be substantially reduced by applying a multiplicity of standard turbojet engines as a gas generator.

Installation and Operation of a Gas Flow Control System. G. V. Schwent, W. K. McGregor, D. W. Russell, and Lee F. Burns. *ISA J.*, Dec., 1956, pp. 499–502. Explanation of the hardware of the automatic system, with consideration given to the design criteria imposed by the practical aspects of the physical process, and simplified description of the AEDC Engine Test Facility.

The Application of the Shock Tube to the Study of High Temperature Phenomena in Gases. A. Hertzberg. *Appl. Mech. Rev.*, Dec., 1956, pp. 505–509. 53 refs. Discussion of shock-tube application in connection with the study of hypersonic flight, high-temperature chemical kinetics, and high-temperature gas physics. Includes review of some of the more important recent theoretical and experimental investigations.

Visualization of Low-Density Flows by Means of Oxygen Absorption of Ultraviolet Radiation. Pauline M. Sherman. *J. Aero. Sci.*, Feb., 1957, pp. 93–98, 106. WADC-sponsored experimental investigation using a vacuum spectrograph-monochromator camera with a 1,470Å. radiation to photograph shock waves formed by flow over a sphere, a cone-cylinder, wedges, and a cylinder with axis aligned parallel to the direction of flow.

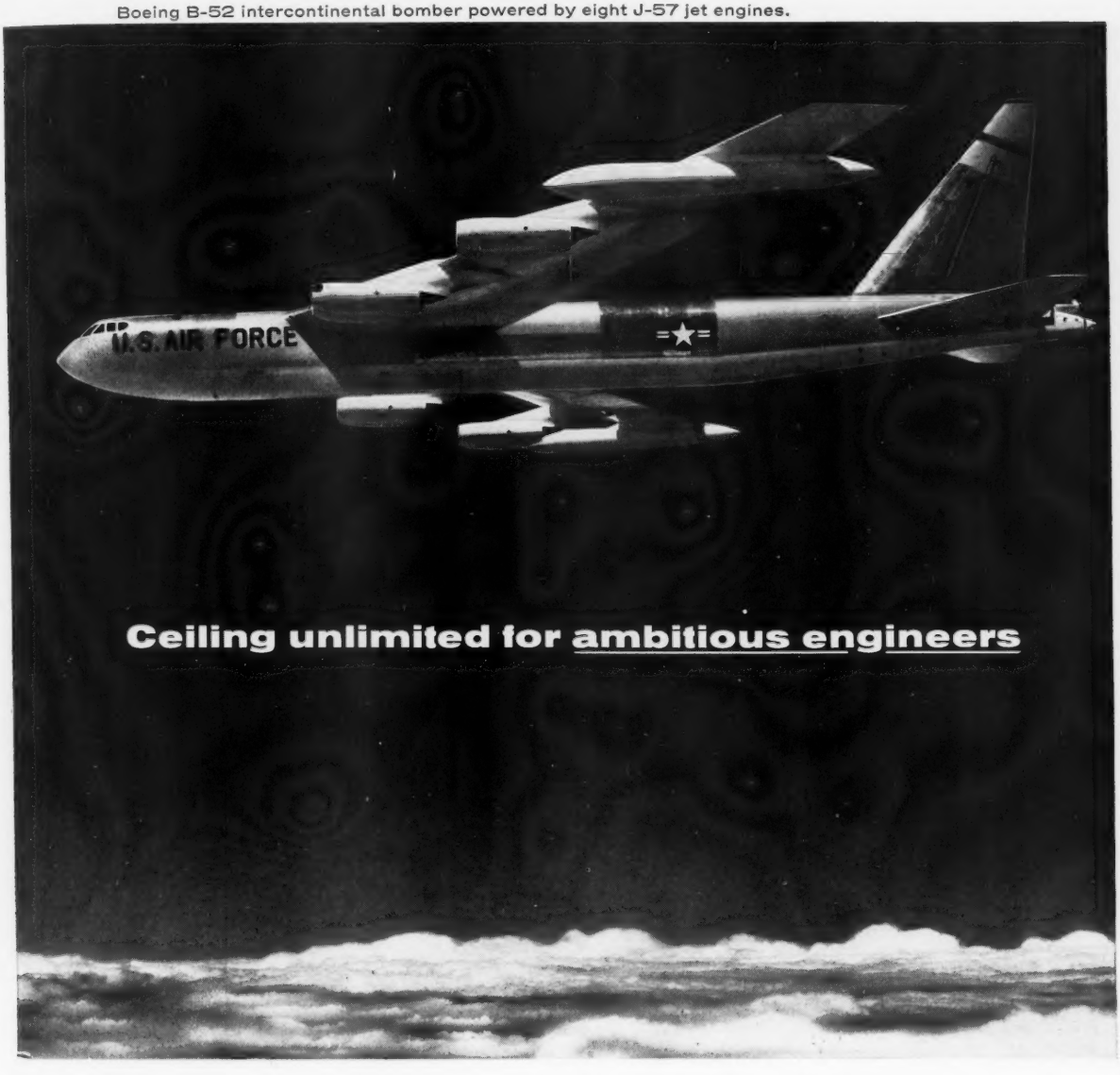
Interféromètre à Lumière Polarisée; Application à la Dynamique des Gaz. Gérard Gontier. *Inst. Méc. Fluides, Lille, Prob. 286 SR*, May 12, 1956. 93 pp. 34 refs. In French. Analysis of optical methods of flow visualization including shadowgraph and schlieren techniques. Description of a polarized-light interferometer used in a sonic wind tunnel.

Some Possibilities of Using Gas Mixtures Other Than Air in Aerodynamic Research. Appendix A—**Estimate of Deviations from Thermal Perfection.** Appendix B—**Relaxation-Time Data and Estimate of Effect for Various Gas Mixtures.** Appendix C—**Relation Between Bulk Viscosity and Relaxation Time.** Dean R. Chapman. *U.S., NACA Rep. 1259*, 1956. 22 pp. 81 refs. Supt. of Doc., Wash., $0.25.

Model Aircraft for Research. Joseph J. Muncey. *Res. Trends (Cornell Aero. Lab.)*, Fall, 1956, pp. 1–4. Description of the procedure used at the Cornell Aeronautical Laboratory for designing and constructing wind-tunnel models.

Similitude Relations for Free-Model Wind-Tunnel Studies of Store-Dropping Problems. Appendix—**Test Method Used in The Preflight Jet.** Carl A. Sandahl and Maxime A. Faget. *U.S., NACA TN 3907*, Jan., 1957. 26 pp. Methods are presented for dynamically scaling models for wind-tunnel store-dropping studies. The

Boeing B-52 intercontinental bomber powered by eight J-57 jet engines.



Ceiling unlimited for ambitious engineers

MECHANICAL DESIGNERS

Graduate engineers for challenging assignments in the design of turboprop, turbojet and advanced aircraft engines and their components. Experience desirable in compressors, turbines, aerodynamics, hydraulics, gears, valves, bearings, piping, controls, afterburners and related equipment, heat exchangers and combustion problems.

DESIGNERS OF INDUSTRIAL EQUIPMENT

Work involves the design of mechanical and electrical equipment for experimental testing of aircraft engines and their components. The following are typical of the projects handled by the department: DESIGN of gear box and drive motor installations • DESIGN of blower systems and air piping • LAYOUT of piping systems for water, steam, air, oil, fuel • DESIGN of special jet engine instrumentation • DESIGN of mechanical assemblies — gear boxes, drive shafts, couplings • DESIGN of engine test cells.

EXPERIMENTAL ENGINEERS

Mechanical and electrical engineers to work on experimental assembly and test of gas turbine engines, including the development of control systems, compressors, combustors, turbines, afterburners, bearings, seals and fuel controls.

SALES DEPARTMENT ENGINEERS

Mechanical or aeronautical engineering graduates for engine and airplane performance analysis, field engineering, engine mock-up, technical publication writing and spare parts sales data analysis; also as engine operation specialists and for work involving installation project requirements.

★ ★ ★

Please send your complete resume to Mr. P. R. Smith, Office 69, Employment Department.

PRATT & WHITNEY AIRCRAFT

DIVISION OF UNITED AIRCRAFT CORPORATION • 366 MAIN ST., EAST HARTFORD, CONN.

World's foremost designer and builder of aircraft engines

light-model method gives exact simulation of the store motions except that the vertical displacements are deficient. The heavy-model method gives complete simulation of the store motion except that the short-period longitudinal oscillation is too poorly damped.

Transonic Tunnel Testing Technique. H. F. Vessey. *The Engr.*, Dec. 28, 1956, p. 921. Evaluation of wind-tunnel ventilation techniques used to reduce or eliminate shock reflections.

The Development of an Improved Diffuser for the 3 ft. × 3 ft. Tunnel, Royal Aircraft Establishment, Bedford. J. B. Scott-Wilson and D. I. T. P. Llewelyn-Davies. *Gt. Brit., RAE TN Aero. 2446*, July, 1956. 13 pp.

The Second Test Region of a Free-Jet Supersonic Wind Tunnel as a Region of Variable Mach Number. J. D. Lee and G. L. Von Eschen. *USAF WADC TR 56-337*, June, 1956. 19 pp. Method of using a supersonic nozzle designed for a fixed Mach Number in order to obtain a test region of theoretically uniform supersonic flow whose Mach Number may be varied rapidly over a moderate range. The research was performed in a 12 × 12-in. supersonic, free-jet, blowdown wind tunnel.

Flow Direction Measurements in Supersonic Wind Tunnels. D. J. Raney. *Gt. Brit., ARC CP 262 (ARC TN Aero. 2342*, Sept., 1954), 1956. 17 pp. BIS, New York, $0.54. Discussion in which some general requirements for satisfactory flow-direction measurements are stated, and examples are given of the design and calibration of typical yawmeters.

Sur une Méthode de Visualisation des Écoulements Supersoniques. G. Dubois. *La Recherche Aéronautique*, Sept.-Oct., 1956, pp. 33–42. In French. Development of a method of supersonic-flow visualization.

A Note on Derivative Apparatus for the N.P.L. 9½ Inch High Speed Tunnel. J. B. Bratt. *Gt. Brit., ARC CP 269*, Jan. 11, 1956. 10 pp. BIS, New York, $0.36. Description of apparatus to measure complete sets of derivatives related to pitching, vertical translation, and flap rotation for finite aspect-ratio models.

Wind Tunnel Models. R. P. Davie. *NATO AGARD Rep. 19*, Aug., 1956. 56 pp. Discussion of the design and construction of wind-tunnel models for North American Aviation Company.

The Effect of Transition Wires on the Pressure Distribution Over a N.A.C.A. 63A215 Aerofoil Section. K. D. Harris. *Coll. of Aeronautics, Cranfield, TN 41*, Feb., 1956. 35 pp. Test results which show that with the transition lift free, laminar separation—followed by turbulent reattachment—occurs at about 60 per cent chord at low incidences. At medium incidence the position of laminar separation and turbulent reattachment moves rapidly forward giving rise to nonlinearities in the lift curve.

▲ ▲ ▲

Sherman M. Fairchild Publication Fund Papers

No.		Member Price	Non-member Price
FF-14	Engineering Management Philosophies (A Symposium).	$0.50	$1.00
FF-13	The Floating Integrating Gyro and Its Application to Geometrical Stabilization Problems on Moving Bases—C. S. Draper, W. Wrigley, and L. R. Grohe.	1.00	1.50
FF-12	Transonic Testing Techniques (A Symposium).	1.85	2.50
FF-11	Wetted Area and Center of Pressure of Planing Surfaces at Very Low Speed Coefficients—Experimental Towing Tank, Stevens Institute of Technology.	1.20	1.60
FF-10	Improved Solutions of the Faulkner and Skan Boundary-Layer Equation—A. M. O. Smith.	0.75	1.25
FF-9	A Hydrodynamic Study of the Chines-Dry Planing Body—Experimental Towing Tank, Stevens Institute of Technology.	1.20	1.60
FF-8	Compressive Buckling of Plates Due to Forced Crippling of Stiffeners, **Parts I and II**—P. P. Bijlaard and G. S. Johnston.	1.30	2.00
FF-7	Natural Flight and Related Aeronautics—James L. G. Fitz Patrick.	2.65	3.50
FF-6	Wetted Length and Center of Pressure of Vee-Step Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	1.20	1.60
FF-4	Finite Deflections of Curved Sandwich Plates and Sandwich Cylinders—F. K. Teichmann and Chi-Teh Wang.	0.50	0.85
FF-3	The Penetration of a Fluid Surface by a Wedge—Experimental Towing Tank, Stevens Institute of Technology.	1.20	1.60
FF-2	A Study of the Flow, Pressures, and Loads Pertaining to Prismatic Vee-Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	1.20	1.60
AHS-1	Helicopter Flight Research at NACA, Langley—Jack P. Reeder.	0.35	0.75
286	Linearized Treatment of Supersonic Flow Through Axi-Symmetric Ducts with Prescribed Wall Contours—Charles E. Mack, Jr., and Ignace I. Kolodner.	0.75	1.25
244	Wetted Area and Center of Pressure of Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	$0.75	$1.00
229	Wave Profile of a Vee-Planing Surface, Including Test Data on a 30° Deadrise Surface—Experimental Towing Tank, Stevens Institute of Technology.	1.20	1.60
170	Wave Contours in the Wake of a 10° Deadrise Planing Surface—Experimental Towing Tank, Stevens Institute of Technology.	1.20	1.60
169	The Discontinuous Fluid Flow Past an Immersed Wedge—Experimental Towing Tank, Stevens Institute of Technology.	0.75	1.00
168	Wave Contours in the Wake of a 20° Deadrise Planing Surface—Experimental Towing Tank, Stevens Institute of Technology.	1.20	1.60
167	On the Pressure Distribution for a Wedge Penetrating a Fluid Surface—Experimental Towing Tank, Stevens Institute of Technology.	0.75	1.00
166	An Analysis of the Fluid Flow in the Spray Root and Wake Regions of Flat Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	1.20	1.60
165	Theory and Practice of Sandwich Construction in Aircraft (A Symposium).	1.85	2.50
126	External Sound Levels of Aircraft—R. L. Field, T. M. Edwards, Pell Kangas, and G. L. Pigman.	0.75	1.00
106	Measurement of Ambient Air Temperature in Flight—W. Lavern Howland.	0.35	0.50
104	Tensor Analysis of Aircraft Structural Vibration—Charles E. Mack, Jr.	1.85	2.50
102	Electrical Resistance Strain Gages Applied to Wind-Tunnel Balances—Elmer C. Lundquist.	0.60	0.80
101	Introduction to Shock Wave Theory—J. G. Coffin.	2.65	3.50
100	Blade Pitching Moments of a Two-Bladed Rotor—R. W. Allen.	0.75	1.00

Papers should be ordered by number from: **Publications Dept., IAS, Inc., 2 East 64th St., N.Y. 21, N.Y.**

▲ ▲ ▲

OPPORTUNITY AT GRUMMAN

FOR OUTSTANDING EXPERIENCED ENGINEERS

Structural Designers of Wing, Fuselage, and Tail Surfaces

Aerodynamicists

Electrical (Systems) Engineers for Circuit Design and Layout

Electronics Engineers

Power Plant (Fuel Systems) Engineers

Internal Aerodynamicists (Propulsion & Heat Transfer)

Research Engineers (Theoretical Aerodynamicists, Dynamicists, Mathematicians, Physicists)

Company-financed retirement plan and liberal education plan for advanced study.

Proof of U. S. citizenship required. Apply in person or send resume to:

Mr. A. T. Wilder
Engineering Personnel Director

GRUMMAN

Grumman

GRUMMAN AIRCRAFT
ENGINEERING CORPORATION

Bethpage • Long Island • New York

Altitudes high above ceilings for today's aircraft are simulated in this chamber.

Framed in this doorway... vital questions for engineers

How will it work in the air? At what altitude? For how long? To get the answers, nothing is spared to provide engineers with necessary and top-notch equipment at North American's Columbus Division.

Facilities include 16 completely equipped laboratories. In addition, a new air-conditioned engineering building will soon be completed.

The Columbus Division has prime responsibility for all North American's aircraft projects for the Navy—from concept through flight. It is a vigorous, completely integrated organization where advancement is based on individual recognition. If you are an ambitious engineer who would like an unusual career opportunity, you owe it to your future growth to find out about openings in your field with us.

OPPORTUNITIES IN EVERY PHASE OF AIRCRAFT ENGINEERING

Aerodynamicists, Thermodynamicists, Dynamicists, Stress Engineers, Structural Test Engineers, Flight Test Engineers, Mechanical and Structural Designers, Electrical and Electronic Engineers, Wind Tunnel Model Designers and Builders, Power Plant Engineers, Research and Development Engineers, Weight Engineers.

Get the full story. Write today: Mr. J. H. Papin, Personnel Manager, Dept. 563-AER, North American's Columbus Division, Columbus 16, Ohio.

THE COLUMBUS DIVISION OF

NORTH AMERICAN AVIATION, INC.

Aeronautical Reviews — BOOKS

AERODYNAMICS

Airplane Aerodynamics. Daniel O. Dommasch, Sydney S. Sherby, and Thomas F. Connolly. 2nd Ed. New York, Pitman Publishing Corporation, 1957. 558 pp., illus., diagrs., tables. $7.75.

This text on aerodynamics began as a compilation of material covered in lectures given to pilots attending the Naval Air Test Center prior to 1951. The advances in all branches of the art have necessitated this second edition which has kept pace with the major developments in supersonic flight, boundary-layer systems, power-plant development, and hydrodynamic problems peculiar to seaplanes. Certain out-dated material, such as the NACA standard atmosphere, has been eliminated in favor of more currently accepted data. The part played by thermodynamics, particularly those phases dealing with one-dimensional compressible flow, is amplified in the material on aerothermodynamics. New information on high-speed performance has been added, and the topic of dynamic performance is introduced. A short treatment of dynamic stability has been prepared following very simple lines.

Aerodynamic Measurements. Robert C. Dean, Jr., and Others. Cambridge, Gas Turbine Laboratory, Massachusetts Institute of Technology, 1953. 272 pp., illus., diagr. $8.00.

The persistent demand for a detailed treatment of the unified aerodynamic measurement problem led the Staff of the M.I.T. Gas Turbine Laboratory to produce the first edition of these notes in 1952. This second edition was compiled by the Staff and other faculty members under the general editorship of Mr. Dean and consists mainly of information carefully screened from the body of existing literature on the subject. The purpose of this volume is to enable engineers to interpret their own literature surveys and also the multitude of new developments requiring detailed knowledge of pertinent techniques in the art of mensuration.

Contents: (1) Error Determination and Treatment of Data. (2) Temperature Measurement. (3) Pressure Measurements. (4) Velocity Measurements. (5) Flow Direction Measurements. (6) Hot-Wire Anemometry. (7) Mass-Flow Measurements. (8) Humidity Measurements. (9) Optical Measuring Techniques. (10) The Fundamental Principles of Dynamic Measurement. Appendix A—Review of Fluid Mechanics. Appendix B—Bibliography. Appendix C—Psychometric Charts.

Führer durch die Strömungslehre (Guide to the Dynamics of Fluids). Ludwig Prandtl. 4th Unrevised Ed. Braunschweig, Friedr. Vieweg & Sohn, 1956. 407 pp., figs. DM 19.80. In German.

This is a reprint of the 1949 edition. An English translation of this 1949 edition was published in 1952, under the title of *Essentials of Fluid Dynamics*, by Hafner Publishing Co., New York, and Blackie & Son, Glasgow.

AIR TRANSPORTATION

The Role of Air Freight in Physical Distribution: Part 1, Characteristics of Air Freight and its Market. Howard T. Lewis and James W. Culliton. **Part 2, Two Case Studies.** Jack D. Steele. Boston, Division of Research, Graduate School of Business Administration, Harvard University, 1956. 180 pp., diagrs., tables. $2.50.

This study was initiated in the fall of 1953 to ascertain and to explore the key problems involved in any future expansion of the volume of domestic air freight. Whereas previous studies in this series dealing with the business aspects of aviation were devoted to management problems of the industry, *Part 1* of the present study concerns itself with the market for the industry. The exploration of physical distribution is directly related to studies in manufacturers' marketing costs. The broad approach to the question attempts to outline the time, place, and propitious circumstances for the use of air freight. The authors are Howard T. Lewis, Professor of Marketing, Emeritus, Harvard Business School, and James W. Culliton, Dean, College of Commerce, University of Notre Dame. *Part 2* of the book contains two detailed case studies which apply some of the findings to specific business situations. Each case illustrates one facet of an approach to an analysis of the potential utility of air freight in physical distributions. Neither case presents a complete analysis, but each suggests one kind of detailed study appropriate to an analysis of the broad problem. These two examples became part of the doctoral thesis at Harvard Business School for Dr. Steele, Associate Professor of Business Administration, University of Kansas.

Partial Contents: *Part 1*: (1) Character, Size, and Scope of Air Freight. (2) Characteristics of the Market—Users. (3) Air Freight and the Physical Distribution Function of Business. (4) Market Characteristics—Potential Users. (5) Conclusions and Suggestions.

AVIATION MEDICINE

Disease Control and International Travel; A Review of the International Sanitary Regulations. H. S. Gear and Z. Deutschman. (Chronicle of the World Health Organization, Vol. 10, 1956, pp. 273–340.) Geneva, World Health Organization, 1956. 73 pp., illus., diagrs., maps, tables. $0.70.

COMPUTERS

Electronic Computers: Principles and Applications. Edited by T. E. Ivall. London, Iliffe & Sons, Ltd.; N. Y., Philosophical Library, 1956. 167 pp., illus., diagrs. $10.

A nonmathematical introduction to the principles and applications of computers employing tubes and other electronic devices, primarily written for technicians, engineers, and students with a knowledge of electricity or electronics, but also suitable for business executives. The treatment has been made as general as possible in order to give a broad background picture of the whole field of computing from which the reader can pass on to more advanced and specialized studies.

Both digital and analog computers are covered, and comparisons are made between the two types. The bulk of the book is devoted to describing their circuitry and construction, while their rapidly developing applications in industry, commerce, and science are also outlined. Here considerable emphasis is placed on the application to "automation" techniques in industry and also on the use of analog computers as simulators or "models" of control systems. In the final chapter the future evolution of computers is discussed.

For information on IAS Library Services, see page 83

Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

DICTIONARIES

Aeronautical English; Technical Dictionary and Manual of Aviation. Alfred Oppermann. Munich, Aeronautischer Verlag and Luftreklame, 1955. 1,170 pp., illus. DM 26.-.

Those who translate technical and scientific aeronautical literature from German into English, or vice versa, should find this dictionary and handbook a valuable addition to their reference shelves. The vocabulary reflects recent developments in the field and is comprehensive, including as it does many terms from physics, mathematics, mechanics, and electronics. Approximately 30,000 terms are found in the German-English section; approximately 24,000 in the English-German. These two sections make up about 60 per cent of the text.

The handbook sections, in English and German, cover the following topics: conversion tables; international aeronautical abbreviations; the international Q-code; standard voice communication phraseology; navigation and meteorology (illustrated); definitions (with illustrations and cutaway drawings) of aircraft, parts, and power plants; illustrations and specifications of aircraft and power plants. The author's aeronautical experience includes flying with the earlier Deutsche Lufthansa and the German Air Force in World War II and work with the U.S. Air Force after 1945.

EDUCATION

Extraclass Activities in Aviation, Photography, Radio, for Secondary School Pupils; Suggestions for School Administrators and Sponsors. Willis C. Brown. (U.S. Office of Education, Bulletin 1956, No. 11.) Washington, Superintendent of Documents, 1956. 48 pp., illus. $0.25.

A review of good practices in three fields important to the nation's scientific and technological progress. The intent is that schools now having such programs may be able to improve them and those having none may be stimulated to start them.

FLIGHT ENGINEERING

Flight Engineers Manual: With Typical Multiple-Choice Questions and Answers for the Flight Engineer Examination. Charles A. Zweng. 4th Ed. North Hollywood, Calif., Pan American

Navigation Service, 1956. 304 pp., illus., diagrs. $5.00.

GAS DYNAMICS

Gas Dynamics. Klaus Oswatitsch. English Version by Gustav Kuerti. (Applied Mathematics and Mechanics Series, Vol. 1.) New York, Academic Press, 1956. 610 pp., diagrs., illus., charts. $12.

This is the first volume of a series of monographs prepared under the auspices of the Applied Physics Laboratory, The Johns Hopkins University. The purpose of this series is to make available to physicists, applied mathematicians, and research engineers material on certain aspects of applied mathematics and mechanics for which there is a need in the scientific literature.

The author, who is Director of the Institute for Theoretical Gas Dynamics of the DVL at Aachen, points out that this volume is not intended to serve as an engineering handbook. Rather the emphasis is upon the fundamental equations and formulas of gas dynamics together with a survey of the advanced methods of analysis not generally found within textbooks on aeronautical engineering. The general theorems of gas dynamics are formulated so as to refer, wherever possible, to an arbitrary, physically homogeneous medium, while special examples have usually been worked out for a perfect gas with constant specific heat.

Contents: (1) Thermodynamics. (2) Steady One-Dimensional Flow. (3) Unsteady One-Dimensional Flow. (4) General Equations and Theorems. (5) Application of the Integral Theorems in Particular Cases. (6) General Equations and Particular Exact Solutions for Steady Inviscid Flow. (7) Steady Inviscid Plane and Axisymmetric Subsonic Flow. (8) Steady Inviscid Plane and Axisymmetric Supersonic Flow. (9) Steady Inviscid Transonic Flow. (10) Steady and Unsteady Three-Dimensional Flow Problems. (11) The Influence of Viscosity. (12) Survey of Experimental Techniques; Flow Analogies.

150 YEARS OF PUBLISHING

1807 1957

LOOKING FORWARD

Robert Fulton's marvelous steamboat
fired the minds of forward-looking men
when she churned up the Hudson
in 1807.

To the House of Wiley, founded that same year,
the *Clermont's* voyage opened up
a new and exciting frontier in publishing.

If America were to exploit her new industrial age,
pioneering books would have to be provided.
It is this demand — greater in 1957 than ever —
that Wiley has been meeting successfully
for one hundred and fifty years.

Today, the *Clermont's* atom-powered granddaughter
slips through the seas . . .
the scientific community continues to expand . . .
and, planning for the future,

John Wiley & Sons looks forward to publishing
an ever-greater number of distinguished books
in all areas of pure and applied science.

JOHN WILEY & SONS, Inc.
440 Fourth Avenue, New York 16, N. Y.

LAWS AND REGULATIONS

Civil Air Regulations in Plain English for All Pilots. Sam R. Hamilton. Minneapolis, T. S. Denison & Company, 1957. 95 pp., illus. $3.00.

MATHEMATICS

Relaxation Methods in Theoretical Physics; A Continuation of the Treatise: Relaxation Methods in Engineering Science; Vol. 2. R. V. Southwell. Oxford, Clarendon Press; New York, Oxford University Press, 1956. 272 pp., diagrs. 55*s*. $8.80.

Volume 1 of this work on relaxation methods was published in 1946. It dealt with problems which involved two independent variables and which were governed by equations of the second order. The tracing of its many elaborate diagrams and the further development and extentension of the relaxational technique (mainly by Prof. D. N. de G. Allen) have delayed the publication of the second volume.

Volume 2 discusses equations of higher order than the second, equations involving three independent variables, and equations that are nonlinear. Reworking has yielded not only more exact solutions but, for several problems, improvements of technique. For eigenvalue problems, in particular, more powerful methods have been devised. Each volume is a self-contained entity, but the set has been planned as one unit in the arrangement of sections and by continuous pagination. A bibliography accompanies each chapter. The two volumes, together with the author's *Relaxation Methods in Engineering Science* (1940), present a comprehensive survey of relaxation methods for the 20 years since 1935. Dr. Southwell is Honorary Fellow, Brasenose College, Oxford; Trinity College, Cambridge; and Imperial College, London.

Contents: (7) Relaxation Methods Applied to Biharmonic Problems, I. (8) Relaxation Methods Applied to Biharmonic Problems, II. (9) 'Two-Diagram Technique' as an Alternative to Use of the 'Biharmonic Pattern.' (10) Other Applications of 'Two-Diagram Technique'; Stress-Systems in Solids of Revolution. (11) Eigenvalue Problems; 'Normal' Vibrations of Mechanical and Electrodynamic Systems. (12) The Elastic Stability of Flat Plating Subjected to Tractions in the Plane of its Middle Surface. (13) Non-Linear Problems; Large Flexural Distortion of Flat Elastic Plates. (14) Non-Linear Problems in Hydrodynamics and Plasticity. (15) Further Developments: 'Three-Dimensional Relaxation'; Heat-Conduction, and Other 'Transient' Problems. Papers, Etc., Concerned with Relaxation Methods. Index of Problems Solved. Name Index. Index of Matters Treated.

Elements of Pure and Applied Mathematics. Harry Lass. New York, McGraw-Hill Book Company, Inc., 1957. 491 pp., diagrs., tables. $7.50.

This text is an outgrowth of courses given by the author at various colleges and universities during the past 16 years. Dr. Lass, presently Research Specialist, Jet Propulsion Laboratory, California Institute of Technology, and Mathematics Lecturer for the U.C.L.A. Orange Belt Graduate Program, intends his work both as a reference book for all readers and as a text for upper-division undergraduates majoring in physical science, engineering, and mathematics. Thorough discussion is given to the various subjects in classical mathematics most useful to the engineer and physicist. The material has been so written that each chapter is independent of the others although many cross references tend to unify the subjects at hand. There are a considerable number of examples worked out in detail, and problems follow each section. Extensive bibliographies follow each chapter.

Contents: (1) Linear Equations, Determinants, and Matrices. (2) Vector Analysis. (3) Tensor Analysis. (4) Complex-Variable Theory. (5) Differential Equations. (6) Orthogonal

THE IAS LIBRARY

Publications treated in the "Aeronautical Reviews" sections are maintained by the Library for use by the IAS Membership. They are *not* for sale but are made available through the facilities of the Library.

LENDING SERVICES: Institute members, both Individual and Corporate, may borrow periodicals, reports, and books for a period of 2 weeks, excluding time in transit. Excepted are certain reference books and those IAS publications that may be purchased.

PHOTOCOPY SERVICES: The Library is equipped to provide, as a service, positive photocopies of certain materials in its collections. Rates on request.

For detailed information about these and other services, write to:

John J. Glennon, Librarian
Institute of the
Aeronautical Sciences, Inc.
2 East 64th Street
New York 21, New York

The Dynamics and Thermodynamics of Compressible Fluid Flow

ASCHER H. SHAPIRO, *Massachusetts Institute of Technology*

OUTSTANDING two-volume work covers virtually all aspects of compressible fluid mechanics. Ranging in scope from fundamentals to analytical development of design methods, it organizes a fund of up-to-date material directly applicable to engineering problems in high-speed aircraft and rocket design.

Vol. I: *635 ills., tables; 647 pp.*
Vol. II: *560 ills., tables; 537 pp*
Each $16.00, Set $30.00

GAS TURBINES for AIRCRAFT

IVAN H. DRIGGS, *U. S. Naval Air Development Center;* OTIS E. LANCASTER, *Assistant Director, Research Division, Bureau of Aeronautics, Department of the Navy*

AUTHORITATIVE, thorough reference guide for all concerned with the design and performance of gas turbines in aircraft. Covers gas turbine performance, control problems, and aircraft analysis. All material of possible interest has been included, making it unnecessary for the reader to refer to other books or reports. *213 ills.; 10 charts, tables; 349 pp.* **$10.00**

• *Order books from:*

THE RONALD PRESS COMPANY
15 East 26th Street, New York 10

Polynomials, Fourier Series, and Fourier Integrals. (7) The Stieltjes Integral, Laplace Transform, and Calculus of Variations. (8) Group Theory and Algebraic Equations. (9) Probability Theory and Statistics. (10) Real-Variable Theory. Index.

Bibliography of Russian Mathematics Books. George E. Forsythe. New York, Chelsea Publishing Company, 1956. 106 pp. $3.95.

The purpose of this survey is to bring before Western mathematicians the significant contributions of Soviet workers to the fields of pure and applied mathematics. All known books published or reprinted in Russian or Ukrainian since 1930 are listed by author and subject. Because of their mathematical interest, most of the serial monographs of the Steklov Mathematical Institute have also been included.

The subject matter of the books listed is mathematics, pure and applied, including tables beyond the most elementary but excluding descriptive geometry. There are a few titles on quantum mechanics and other branches of mathematical physics, mechanics, mathematical machines, and nomography. For textbooks the subject matter is more advanced than calculus.

Transactions of the Symposium on Partial Differential Equations; Held at the University of California at Berkeley, June 20–July 1, 1955. Sponsored by Office of Naval Research, University of Kansas, and American Mathematical Society. (Reprinted from *Communications on Pure and Applied Mathematics*, Vol. 9, No. 3, 1956.) New York, Interscience Publishers, Inc., 1956. 334 pp. $6.50.

Contents: Some Criteria of Normality of Families of Continuous Functions, Maynard G. Arsove. Some Hints on Huygens' Principle and Hadamard's Conjecture, Leifur Ásgeirsson. Multivalued Harmonic Functions in Three Variables, Stefan Bergman. Survey of Local Properties of Solutions of Elliptic Partial Differential Equations, Lipman Bers. On the Regularity Properties of Solutions of Elliptic Differential Equations, Felix E. Browder. On the Calculus of Variations in Two Variables, Lamberto Cesari. Discontinuity of Solutions of Quasi-Linear Differential Equations in Two Variables, Y. W. Chen. On Singular and Regular Cauchy Problems, J. B. Diaz. A Criterion for the Validity of Huygens' Principle, Avron Douglis. Singularities of Generalized Axially Symmetric Potentials, Arthur Erdélyi. Growth Properties of Solutions of Non-Linear Elliptic Equations, Robert Finn. Difference Methods on a Digital Computer for Laplacian Boundary Value and Eigenvalue Problems, George E. Forsythe. On the Local Behavior of Solutions of $\Delta u = g(x, u, \nabla u)$, Philip Hartman. The Scope and Limitations of the Method of Wiener and Hopf, Albert E. Heins. On the Existence Problem for Surfaces of Constant Mean Curvature, Erhard Heinz. On the Reflection Principle for Polyharmonic Functions, Alfred Huber. On Linear Differential Equations in Banach Spaces, Tosio Kato. An Unsymmetric Operator Arising in the Theory of Neutron Diffusion, Joseph Lehner. A Variational Method in the Theory of Harmonic Integrals, Charles B. Morrey, Jr. Estimates and Existence of Solutions of Elliptic Equations, Louis Nirenberg. New Isoperimetric Inequalities for Eigenvalues and Other Physical Quantities, L. E. Payne. Remarks on Courant's Nodal Line Theorem, Åke Pleijel. Remarks on the Application of Gradient Mappings to the Calculus of Variations and the Connected Boundary Value Problems in Partial Differential Equations, E. H. Rothe. Mean Values and Continuity of Riesz Potentials, Kennan T. Smith. On Radiation Conditions, J. J. Stoker. A Direct Approach to the Problem of Stability in the Numerical Solution of Partial Differential Equations, John Todd. Upper and Lower Bounds of Eigenvalues by Finite Difference Methods, H. F. Weinberger. Some New Methods in Two-Dimensional Variational Problems with Special Reference to Minimal Surfaces, L. C. Young.

HELP
for engineers!
STANPAT—the remarkable tri-acetate that is pre-printed with your standard and repetitive blueprint items, easily transferred to your tracings by an adhesive back or front. Relieves time-consuming and tedious detail of re-drawing and re-lettering specification and revision boxes, standard symbols, sub-assemblies, components and cross-sections. Saves hundreds of expensive hours of drafting time and money, frees the engineer for concentration on more creative work.
so simple to use:
① PEEL the tri-acetate adhesive from its backing.
② PLACE the tri-acetate in position on the tracing.
③ PRESS into position, will not wrinkle or come off.
Stanpat Co.

STANPAT CO., Whitestone 57, N. Y., U.S.A.
Phone: FLushing 9-1693-1611 DAR3

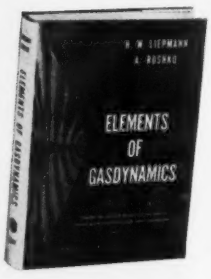
☐ Please quote on enclosed samples.
☐ Kindly send me STANPAT literature and samples.

Name_____
Title_____
Company_____
Address_____

Timely...

basic...

complete...



ELEMENTS of GASDYNAMICS

By H. W. Liepmann and A. Roshko, both of California Institute of Technology

Here is an entirely new book written especially to prepare you for work in modern gasdynamics and high speed aerodynamics. Keeping pace with recent developments in the field, the authors stress the modern aspects of fluid aerodynamics and discuss such topics as the effects of dissociation and ionization, and gas kinetics.

This thoroughly practical study concentrates on the *fundamentals* of gas dynamics, going no further into applications than necessary to illustrate theory. The emphasis is on those underlying principles of design which the reader may apply to any situation.

Information-packed chapters cover:

Concepts from Thermodynamics—One-Dimensional Gasdynamics—One-Dimensional Wave Motion—Waves in Supersonic Flow—Flow in Ducts and Wind Tunnels—Methods of Measurement—The Equations of Frictionless Flow—Small Perturbation Theory—Transonic Flow—Viscous Shear and Heat Transfer—Concepts from Gaskinetics.

A Publication in the GALCIT Aeronautical Series, Theodore von Kármán and Clark B. Millikan, editors.

1957 439 pages 167 illus. $11.00

The PLASTIC METHODS of STRUCTURAL ANALYSIS

By B. G. NEAL, University College of Swansea

The first full-length discussion of methods which lead to the fullest possible economy of material in clear, concise and practical language.

1957 353 pages Illus. $7.50

Send for your ON-APPROVAL copy today!

JOHN WILEY & SONS, Inc. AER-17
440 Fourth Ave., New York 16, N. Y.

Please send me the book(s) checked below to read and examine ON APPROVAL. In 10 days I will return the book(s) and owe nothing, or I will remit the full purchase price(s), plus postage.

☐ ELEMENTS OF GASDYNAMICS $11.00

☐ THE PLASTIC METHODS OF STRUCTURAL ANALYSIS $7.50

Name .....

Address .....

City .....Zone.... State.....

(☐) SAVE POSTAGE. Check here if you ENCLOSE payment, in which case we pay postage. Same return privilege, of course.

MILITARY AVIATION

An Air Power Bibliography. Raymond Estep. Air University Documentary Research Study (AU-252-54-RSI). Maxwell Air Force Base, Ala., U.S. Documentary Research Division, Research Studies Institute, Air University, March, 1956. 200 pp.

This annotated bibliography is designed primarily for use of the students and faculty members of the Air University, but it is expected to prove of value to persons in other commands. Coverage, especially of periodical materials, is primarily for the period after January 1, 1950. For the earlier period, Dr. Eugene M. Emme's *National Air Power and International Politics* (1950) should be consulted.

For the convenience of the user, either a library call number or an archival call number is shown for books and pamphlets. These numbers indicate that the items marked are available in the Air University Library or in the Archives Branch of the USAF Historical Division, Research Studies Institute. Those in the latter collection consist of documented narrative historical studies, some in print, others in typescript. Entries in the *Bibliography* are arranged alphabetically by title within the subject classifications in the contents. A subject index, an author index, a glossary of abbreviations and other terms used in this volume, a list of abbreviated names of publishers, and a list of periodicals are provided. The author index includes citations to published books, articles, speeches, and interviews; it also includes references to editors, interviewers, and translators. The material for the most part deals with the nontechnical aspects of aeronautics.

Partial Contents: Arctic and Antarctic Aviation. Avionics. Education and Training. Flying Safety. Foreign Aviation. Geopolitics. Meteorology. Personnel. Psychological Warfare. Test Pilots. Weapons Systems.

MISSILES

Operations Research; Armament; Launching. Grayson Merrill, Harold Goldberg, and Robert H. Helmholz. (Principles of Guided Missile Design; Grayson Merrill, Editor.) Princeton, N.J., D. Van Nostrand Company, Inc., 1956. 508 pp., illus., diagr., tables. $10.

This is the third volume in a series prepared for graduate students, professional engineers, instructors, and technical officers of the Armed Services who are engaged in guided-missile design and operation. The technologies of operations research as a decision-making tool, armament design as it relates to target destruction, and launching system design as a means of achieving initial flight are selectively covered by recognized authorities in their fields.

"Operations Research" was written by Capt. Grayson Merrill, USN, editor of the entire series and Technical Director of the Jupiter Ballistic Missile Project in the Bureau of Ordnance. The author makes the point that the first principle of guided-missile design is to meet the requirements of the customer, in this case the Armed Services, but that operations research itself is a joint Government-industrial task supported by pure and applied research carried on in the nation's colleges and universities. Sample problems are employed to show how operational requirements are derived in terms of weapons effectiveness and target considerations, how performance specifications are set, and the manner in which operational suitability and best tactical doctrines are determined by the field operating forces when a missile is delivered to them for evaluation. The fundamental mathematical concepts which are required for work in guided-missile operations are introduced in a long chapter entitled "Mathematics of Operations Research," wherein the importance of probability and statistical theory in determining missile system effectiveness is shown. Some examples of operational missile analysis are given, including vectoring errors, kill probability, and the application of statistical methods to missile systems operations research. A glossary of special terms pertaining to operations research concludes this portion of the volume.

The section on "Armament," which was contributed by Harold Goldberg, Vice-President for Research, Emerson Radio & Phonograph Company, discusses the triad of components embodied in a target-destroying missile: warhead, fuse, and safety and arming mechanism. Targets are placed in their logical categories, and their vulnerability to damage is assessed. The destructive potential of a missile as enhanced by various types of warhead is fully explained, especially in the section devoted to nuclear warheads and their effects. Fusing agents are treated by classes, types, and application as related to the particular gunnery problem involved and the fire control concept employed for warhead detonation. The critical role played by safety and arming mechanisms in ensuring the safety of the missile is explained, and a typical systems engineering case illustrates how armament development proceeds from design requirements to field test and evaluation. Mr. Goldberg also supplies a short glossary of special terms relating to armament components and usage.

The "Launching" section was written by Robert M. Helmholz of the Naval Air Missile Test Center, Point Mugu, Calif. The factors which influence the selection of launching techniques and configurations—such as size, weight, handling and loading, and tactical considerations—are discussed here. Various types of booster assemblies, catapults, and air-borne and surface launchers are described together with the basic considerations which enter into their design—namely, reliability, safety, performance, serviceability, and cost. The section concludes with an analysis of the unique design parameters of air-borne launchers and missile launching configurations.

NUCLEAR ENERGY

Metallurgy and Fuels, Vol. 1. Edited by H. M. Finniston and J. P. Howe. (Progress in Nuclear Energy, Series 5.) New York, McGraw-

Over 85% of the torque wrenches used in industry are

STURTEVANT TORQUE WRENCHES

Read by Sight, Sound or Feel.

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch grams...inch ounces...inch pounds ...foot pounds (All sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

P.A. STURTEVANT CO.
ADDISON (QUALITY) ILLINOIS

IN CALIFORNIA

Immediate Openings for

HIGH LEVEL ENGINEERS

experienced in the missile components field

AERODYNAMICS (SUPERSONIC) **GUIDANCE AND CONTROLS**

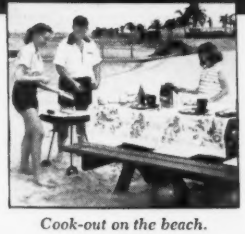
MISSILE STRUCTURES **ROCKET PROPULSION**

Solar is now forming a new creative engineering group for a challenging new project. This is an exceptional opportunity to rapidly advance your career . . . while enjoying San Diego's year-around sunny climate and unmatched recreational and cultural advantages. Solar is a medium-size company (2800 people in San Diego) founded in 1927. Personnel policies are advanced, including profit sharing retirement plan. Please send resume of your qualifications and education to Louis Klein, Dept. E-131, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

SOLAR
AIRCRAFT COMPANY

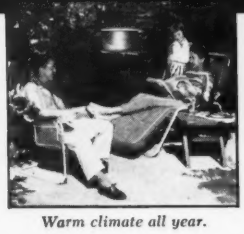
SAN DIEGO
DES MOINES

LIVE BETTER AND ACHIEVE MORE IN SUNNY SAN DIEGO

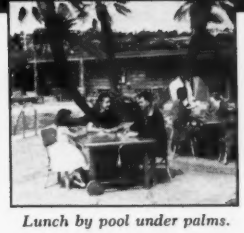


Cook-out on the beach.

Fishing is marvelous!



Warm climate all year.



Lunch by pool under palms.

Hill Book Co., Inc.; London, Pergamon Press Ltd., 1956. 805 pp., illus., diagrs., tables. $21.

This is the first volume devoted to metallurgy and fuels in association with nuclear energy to appear in this new series. The complete series consists of (1) Physics and Mathematics, (2) Reactors, (3) Process Chemistry, (4) Technology and Engineering, (5) Metallurgy and Fuels, (6) Biological Sciences, (7) Medical Sciences, and (8) Economics and Administration.

This present volume reflects the changes in metallurgy that have resulted in the last 15 years from the enforced contact with new engineering requirements and new ideas in physics. The contents exemplify the breadth of metallurgy. The core of the problem is the core of the reactor—the production of serviceable fuel elements, coolants, and moderators. Despite its preoccupation with the limited field of nuclear energy, which precludes a balanced picture of all metallurgical activity, this volume nevertheless touches on most of the topics now being actively studied in research and development laboratories throughout the world. H. M. Finniston is connected with the Harwell Reactor School, and J. P. Howe is associated with North American Aviation, Inc., Canoga Park, Calif.

Contents: (1) The Production and Preparation of Uranium Metal. (2) Thorium. (3) Beryllium and Zirconium. (4) The Physical Metallurgy of Plutonium. (5) The Preparation and Properties of the Rare Earths. (6) Ceramics. (7) Fuel Elements. (8) The Effects of Irradiation. (9) Solid State Physics. (10) Index.

PRODUCTION

Subcontracting Policy in the Airframe Industry. John S. Day. Boston, Division of Research, Graduate School of Business Administration, Harvard University, 1956. 327 pp., diagrs. $4.00.

Together with its companion work, *Management Control in Airframe Subcontracting*, by Neil E. Harlan, this volume completes a study, begun 3 years ago, on the business aspects of aviation. Professor Day's contribution examines the formulation and implementation of a policy for subcontracting in the air-frame industry. The various ideas are discussed in the light of their import to both the industry and the country. Though the report does contain a number of specific illustrations on the manner in which airframe firms have planned and implemented certain phases of their subcontracting efforts, the author's major purpose is to analyze these efforts on an industry-wide basis and not necessarily to decide the best procedure for a specific type of subcontract. Material for the report was gathered from published articles, prime contractor company files, and personal interviews with executives and personnel both within and outside the air-frame industry. The author is Associate Professor of Industrial Management, Purdue University.

Contents: (1) Introduction. (2) An Analysis of the Historical Development of Airframe Subcontracting. (3) Possible Alternatives to a Subcontracting Program. (4) The Significance of Legal and Nonlegal Influences on the Subcontractor. (5) Make or Subcontract—An Analysis of, and the Organization for, the Policy Decision. (6) Selecting the Subcontracting Method and the Product to Subcontract. (7) Selecting the Subcontractor. (8) Predictability of Successful Subcontracting. (9) An Airframe Subcontracting Policy for the Future. Appendices. Bibliography.

Management Control in Airframe Subcontracting. Neil E. Harlan. Boston, Division of Research, Graduate School of Business Administration, Harvard University, 1956. 256 pp., diagrs. $4.00.

This is the companion volume to *Subcontracting Policy in the Airframe Industry*, by John S. Day. Specifically, it deals with the problem of re-establishing control over the three elements of subcontract operation—quality, delivery, and cost. While some techniques and specific approaches are discussed, no ready procedures for administering the details of a subcontract are provided. The book is more concerned with an examination of the kinds of conditions (the types of administrative climate) that are conducive to effective management control. The author, Assistant Professor of Business Administration, Harvard University, also presents what appear to him to be some significant implications of subcontracting operations to weapons systems management and to future national emergencies.

Contents: Introduction. (1) The Nature of the Problem. (2) The Levels of Control. (3) Setting the Stage for Control. (4) Quality Control. (5) Controlling Deliveries. (6) Cost Control—In Purchase-Order Price Negotiations. (7) Cost Control—Subcontractor Cost Reporting. (8) Subcontract Price Redetermination. (9) Changes in the Subcontract. (10) Summary and Conclusions. (11) Some Broader Implications of Airframe Subcontracting.

STRUCTURES

Fatigue in Aircraft Structures: Proceedings of the International Conference Held at Columbia University, January 30, 31, and Feburary 1, 1956. Edited by Alfred M. Freudenthal. Sponsored by the Solid State Sciences Division, Air Research and Development Command, U.S. Air Force, and the Guggenheim Institute of Flight Structures, Dept. of Civil Engineering and Engineering Mechanics, Columbia University, New York, Academic Press, Inc., 1956. 456 pp., illus., diagrs., tables. $12.

Contents: (1) Mechanism of Fatigue, W. A. Wood. (2) The Mechanism of Fatigue in Aluminum and Aluminum Alloys, P. J. E. Forsyth. (3) Experiments Relating to the Origin of Fatigue Cracks, N. Thompson. (4) On the Effects Preceding Fatigue Failure of High-Strength Aluminum Alloys, R. F. Hanstock. (5) Performance of Steel Under Repeated Loading, M. Hempel. (6) Fatigue Cracks as Stress Raisers and Their Response to Cyclic Loading, C. E. Phillips. (7) Scatter of Fatigue Life and Fatigue Strength in Aircraft Structural Materials and Parts, W. Weibull. (8) Accumulation of Fatigue Damage, A. M. Freudenthal and R. A. Heller. (9) Performance Fatigue Testing with Respect to Aircraft Design, E. Gassner. (10) Structural Fatigue Research and its Relation to Design, P. D. Brooks. (11) The Elements of a Helicopter Fatigue Substantiation Program, H. T. Jensen. (12) The Relationship between Load Spectra and Fatigue Life, B. Lundberg and S. Eggwertz. (13) Fatigue Testing in Relation to Transport Aircraft, R. J. Atkinson. (14) Fatigue Engineering in Aircraft, P. Kuhn. (15) Some Remarks on the French Approach to the Problem of Fatigue, J. Cornillon. (16) Aspects of Fatigue Design of Aircraft Structures, F. Turner. (17) The Extent of the Fatigue Problem in Aircraft Design, H. Giddings. (18) Practical Aspects of Fatigue in Aircraft Structures, R. L. Schleicher. (19) Aircraft Structural Fatigue Research in Australia, W. W. Johnstone and A. O. Payne. Author Index. Subject Index.

YEARBOOKS

Jane's All the World's Aircraft, 1956–57. Compiled and Edited by Leonard Bridgman. New York, McGraw-Hill Book Company, Inc., 1956. 454 pp., illus., diagrs. $25.

The present edition has been completely revised and contains 44 more pages than the previous volume. The book is divided into the following eight sections: military aviation, civil aviation, civil air-line operators, airplanes, gas-turbine engines, piston engines, airships, and indexes. The airplane section comprises 314 pages and gives descriptions and specifications of aircraft produced in 29 countries. It has been corrected to August 31, 1956, and includes 752 illustrations, of which 447 are new. An addition to the section is a guided-missile subsection which gives in tabular form the available reliable data on guided missiles, research rockets, and test vehicles known to be in service or under development at press time.

The American section contains 121 pages, 13 more than last year, and 285 illustrations, of which 173 are new. The British industry occupies second place with 62 pages, with 95 of the 149 illustrations being new. The resurging French industry is detailed in 37 pages, 4 more than last year, and carries 89 illustrations, 41 of which are new. A slight relaxation of security and the availability of a number of new photographs have made it possible to enlarge the Russian section from 9 to 14 pages. For the first time since the war, the Federal Republic of Germany appears as a manufacturing country with a small section of 5 pages. Current West German products are mainly of the light airplane or sailplane types. The engine section has 56 of its 90 pages devoted to gas turbines. This information has been extensively revised and contains the most up-to-date material available up to press time. The airship section contains only one entry, the Goodyear Company, which manufactures lighter-than-air craft for the U.S. Navy. Since production is subject to naval classification, little new information is available for publication this year.

Four separate indexes are provided, covering aircraft, rotary-wing aircraft, gas-turbine engines, piston engines, and the manufacturers of each. In addition to references to all items in this edition, each index contains references to every aircraft and engine described in the ten previous editions, going back to and including 1945–1946.

▲ ▲ ▲

Members Elected *(Continued from page 80)*

Trussell, Donald H., B.S. in Ae.E., Aero. Research Engr., NACA (Langley Field).

Turner, Carrol E., B.S. in M.E., Aerodynamics Engr., Convair Div. (Pomona), General Dynamics Corp.

Urey, Harry B., Jr., M.S. in M.E., Capt., USAF; Proj. Engr. (Wright-Patterson AFB).

Variano, Donald J., Stress Analyst, Design Development Co.

Vetter, Alfred F., B. of Ae.E., Aero. Engr., Grumman Aircraft Engineering Corp.

Vincze, John, B.S. in Ae.E., Engr., General Electric Co. (Evendale).

Watson, Howard T., B.S. in Ae.E., Assoc. Aircraft Engr., Lockheed Aircraft Corp. (Marietta).

White, William A., B.A., Service Engr., Douglas Aircraft Co., Inc. (El Segundo).

in Engineering the best Opportunities are in Aviation.

in Aviation the best Opportunities are at Temco.

DESIGN ENGINEERS

Design experience desired in all phases of airframe, equipment, systems and support equipment design. Interest and desire to enter design field is of greater need than amount of experience. Senior positions are available.

SENIOR ENGINEER

Dynamics — Flutter Analysis

3-5 years general flutter analysis experience, including subsonic compressible and supersonic air forces for both straight and swept wing vehicles. Advanced education desired in mathematics, physics, applied mechanics, aeronautical or mechanical engineering.

SENIOR ENGINEER

Analog Computers

Must be thoroughly familiar with latest analog equipment and methods. Should be capable of planning programs involving electronics analog methods and equipment.

ENGINEERING JET TEST PILOTS

Minimum requirements: 1500 hours total pilot time; 500 hours total jet pilot time; test flying experience. Desired qualifications: engineering education; test pilot school graduate; less than 34 years of age. Please include details of engineering, testing and flying history with photograph.

RELIABILITY ENGINEERS

Our expanding weapon systems reliability program offers unusual opportunities. Reliability experience in such areas as: theory, design techniques, components, systems analysis, test, fabrication techniques, and controls is urgently needed.

TEMCO

AIRCRAFT CORPORATION • DALLAS

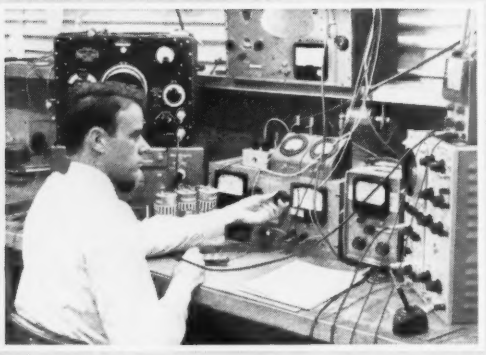
MR. JOE RUSSELL, Engineering Personnel
Dept. 170-A, Room 2, Temco Aircraft Corp.
Box 6191, Dallas, Texas

Please send me complete details of the Temco story of unusual opportunities for creative engineers. I am especially interested in_____

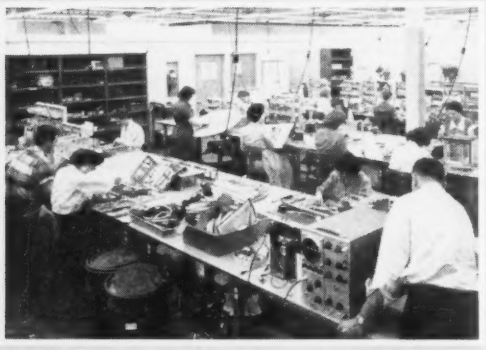
Name_____

Address_____

City_____ State_____

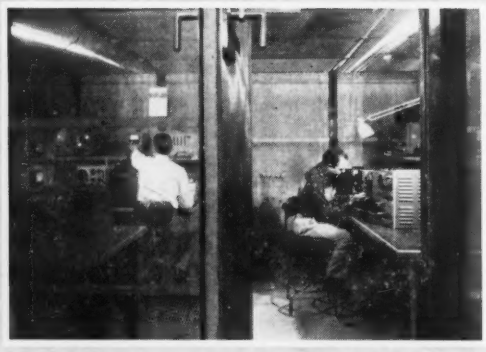


RESEARCH AND DEVELOPMENT



PILOT LINE PRODUCTION

FINAL ASSEMBLY



TESTING IN SCREEN ROOM

COMMUNICATIONS at Ramo-Wooldridge

Communications activities at The Ramo-Wooldridge Corporation include research, development, and manufacture of advanced types of radio communication systems, ground-reference navigation systems, and electronic countermeasure systems. Major programs are in progress in each of these fields.

New and unusual techniques have been employed to provide systems having a high order of security in the transmission of information, broad flexibility in combating unfavorable signal propagation conditions, and substantially greater information capacity per operating channel.

Some of the techniques used have made possible an increased range for given levels of transmitter power and reliability of communications. Others have provided specific advantages in very long distance communications or in operational situations requiring unique signaling capabilities. Developments in navigation systems have resulted in new equipment that is suitable for the guidance of aircraft at long ranges from their bases.

In the work currently under way, some systems are in the laboratory development stage, some in the flight test stage, some are in production. Several types of systems developed and manufactured by Ramo-Wooldridge are in extensive operational use.

Openings exist for engineers and scientists in these fields of communications activities:

- Systems study and analysis
- Airborne transmitters
- Transistorized video and pulse circuitry
- Airborne receivers
- Reconnaisance systems
- Digital communications systems

The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA

Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to Aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

Wanted

Aeronautical Engineers—GS-12 and GS-13 ($7,570-$8,990 a year) in the Bureau of Safety Regulation and the Bureau of Safety Investigation of the Civil Aeronautics Board in Washington, D.C. Specialized experience required in one of the following fields: flight, structures, electronics equipment, instruments and equipment, and power plant. Standard Form 57, Application for Federal Employment, should be sent to Personnel Office, Civil Aeronautics Board, Room B-118, Tempo. 5 Building, Washington, D.C.

Professors—The Air Force Institute of Technology, Wright-Patterson AFB, Ohio, has vacancies in the Department of Mathematics. Most of the work is at advanced undergraduate and graduate level. Employment will be effected in accordance with Civil Service regulations. Grade levels available are GS-9 ($5,440), instructor, GS-11 ($6,390), assistant professor; and GS-12 ($7,570), associate professor. Applications should be made on Standard Form 57, available at any U.S. Post Office, or by letter to Head, Department of Mathematics, Resident Instruction Division, School of Engineering, Air Force Institute of Technology, Wright-Patterson AFB, Ohio.

Engineers—The Navy Department, Bureau of Aeronautics General Representative, Western District, has positions available for aeronautical and electronic engineers in the Los Angeles area at grades GS-12 ($7,570) and GS-11 ($7,035). Persons in these positions deal with industry engineers in the research, development, design, installation, operation, and evaluation of Naval aircraft and major components. Minimum qualifications, B.S. degree in the appropriate or related field of engineering plus 2½ to 4 years of professional engineering experience in the aeronautical field depending on the grade. Interested individuals are invited to write for information or send résumé to Bureau of Aeronautics General Representative, Western District, Room 702, 1206 S. Santee Street, Los Angeles 15.

The number preceding the notice represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

Analytical Engineers—Senior and Junior—Aerodynamic and Thermodynamic—Performance evaluation of advanced aircraft and missile engines. Experience required in one or more of the following fields: compressors, turbines, combustion system design, compressible flow or high-speed rotating equipment. We are seeking engineers who are interested in taking an active part in the development of a new division. Our mission is to design and develop aircraft and missile propulsion systems in the low-to-medium power category. For an outstanding opportunity send résumé to Daniel E. Pinholster, Turbomotor Division, Curtiss-Wright Corporation, Princeton, N.J.

Research Scientists—The Naval Proving Ground has openings for research scientists, whose specialty is aerodynamic theory, to work on challenging assignments associated with missile development. Aeronautical engineers or aerodynamicists with wind-tunnel experience are particularly desired. Appointees will work in an established and growing laboratory which has been assigned an important part in the development of weapons and weapons systems for the Navy. The work of the laboratory involves both the theoretical and the experimental approaches: in making assignments consideration will be given to the individual's particular area of interest and to his preference for a particular type of work. Starting salaries are from $7,035 to $10,065 for qualified experienced aeronautical engineers and physicists. Inquiries should be addressed to Industrial Relations Director, Naval Proving Ground, Dahlgren, Va. A résumé of qualifications and experience should be given, preferably on Standard Form 57.

Engineers—The David Taylor Model Basin, Aerodynamics Laboratory, has openings in applied research for three supervisory aeronautical, research, development, and design engineers in the subsonic, transonic, and supersonic fields. These positions are at the GS-13 level with a yearly salary of $10,065. Numerous other openings for aeronautical engineers, aircraft design engineers, and mechanical engineers are available. These positions are at the GS-5, GS-7, GS-9, and GS-11 levels, with starting salaries of $4,480, $5,335, $6,115, and $7,035, respectively. Application on Standard Form 57 should be sent to The David Taylor Model Basin, Aerodynamics Laboratory, Washington 7, D.C.

Engineers—American Airlines offers an interesting, challenging, and rewarding career in air line engineering to qualified graduate aeronautical, mechanical, and electrical engineers. Non-supervisory positions paying $5,400 to over $10,000 are available in the aircraft engineering fields of power plants (turbojet, turboprop, and reciprocating engines), electricity, electronics, instruments, systems (air conditioning, pressurization, anti-icing, hydraulic, fuel, etc.), cabin interiors, materials and processes, structures,

INDEX TO ADVERTISERS seeking Engineering Personnel

COMPANY AND LOCATION	PAGE
AC Electronics Division, Milwaukee	178
AiResearch Mfg. Divisions, Los Angeles; & Phoenix, Ariz.	74
Armour Research Foundation, Chicago	178
Boeing Airplane Co., Seattle	68
Caltech Jet Propulsion Laboratory, Pasadena, Calif.	180
Chance Vought Aircraft, Inc., Dallas	80
Convair, Pomona, Calif.	149
San Diego, Calif.	5
Cornell Aeronautical Laboratory, Buffalo	138
Douglas Aircraft Co., Inc., Santa Monica, Calif.	153
Fairchild Engine Div., Deer Park, N.Y.	94
General Electric Co., Philadelphia	144
Grumman Aircraft Engineering Corp., Bethpage, N.Y.	165
Hoffman Laboratories, Inc., Los Angeles	177
Johns Hopkins University, Silver Spring, Md.	148
Link Aviation, Inc., Binghampton, N.Y.	177
Lockheed Aircraft Corp., Burbank, Calif.	155, 178
Marquardt Aircraft Co., Van Nuys, Calif.	156
Minneapolis-Honeywell Regulator Co., Minneapolis	126
North American Aviation, Inc., Columbus, Ohio	166
Pennsylvania State University, University Park, Pa.	177
Pratt & Whitney Aircraft Div., East Hartford, Conn.	163
Radio Corporation of America, Camden, N.J.	160
Ramo-Wooldridge Corp., Los Angeles	174
Republic Aviation Corp., Farmingdale, N.Y.	176
Solar Aircraft Co., San Diego, Calif.	171
Southern Calif. Cooperative Wind Tunnel, Pasadena, Calif.	132
Temco Aircraft Corp., Dallas, Tex.	173

PHYSICISTS • GAS DYNAMICISTS
ELECTRICAL and MECHANICAL ENGINEERS
for

PREDICTION ENGINEERING

PROGNOSTICATION DYNAMICS

PROPHECY ANALYSIS

These are not really the titles that Republic Aviation uses to describe the work of its Dynamics Analysis Section—but they justifiably could be.

Why?

Because the work involves the analysis of controls systems in the proposal and design stage—before the mathematics and engineering principles ever take concrete form.*

In Republic's Dynamics Analysis Section you will find some of the best engineering and physics minds in the country. They work in small groups predicting the performance and guiding the design of control complexes for advanced jet-craft and missiles—complexes based on electronic, pneumatic, hydraulic and thermodynamic units.

Openings still exist at Republic for engineers and physicists well grounded in fundamentals. You will find opportunities for using servo design techniques, analog computer methods and the strategems of operations analysis—as well as the more orthodox mathematical tools—in solving problems of varied and stimulating nature.

Training or experience in servo mechanisms is essential, knowledge of analog computer techniques and operations analysis desirable.

Discriminating prophets know that Republic offers the best in professional development, security, working and living conditions. Long Island with its beaches and parks, facilities for every type of recreational activity, nearness to major cultural centers, and with its refreshingly new communities, represents graceful living at its best in the East.

To discover more of the opportunities at Republic, send a complete technical and personal resume to:

Mr. George Hickman, Engineering Employment Manager

REPUBLIC AVIATION
FARMINGDALE, LONG ISLAND, NEW YORK

*Our professional prognosticators have a record to be proud of—development of Republic's famous Thundercraft, latest of which is the incredible F-105 Thunderchief, supersonic USAF fighter-bomber, capable of carrying atomic loads.

operations (flight analysis, weight and balance), and overhaul and test equipment. Small, well-integrated groups of six to ten engineers offer unlimited opportunities for individual recognition and rapid advancement. Contact W. C. Lawrence, Assistant Vice-President—Engineering, American Airlines, Inc., Overhaul & Supply Depot, Tulsa, Okla., for a descriptive brochure. Please send résumé.

Engineers—Fairchild Engine Division of the Fairchild Engine and Airplane Corporation, Deer Park, L.I., N.Y., has diversified engineering positions available involving engine research, design and performance analysis, test engineering, compressor and turbine design, control systems, and other engineering operations associated with the general field of design and development of gas-turbine power plants. These opportunities result from expanded programs in a new plant and gas-turbine laboratory. Send résumé to Felix Gardner, Fairchild Engine Division, Deer Park, L.I., N.Y.

Instructor or Assistant Professor—Needed immediately to teach courses in the following: aircraft design; aeronautical laboratory courses in aerodynamics, instrumentation, propulsion, or structures; and other aeronautical courses. Salary will depend on education and experience; advanced degree preferred. If applicant desires to pursue graduate study, arrangements may be made for part-time schedule. Résumé of education and experience should be furnished in initial reply. Apply to Chairman, Department of Aeronautical Engineering, University of Kansas, Lawrence, Kan.

789. Engineers—Aeronautical, Mechanical—Unusual research and design work in aircraft propulsion, stability, control, and related fields. Advanced degree preferred although not mandatory. Salary high; New York City area.

788. Instructor or Assistant Professor—Expanding aeronautical engineering department of a large New England university requires a man to teach undergraduate courses in applied mechanics and aerodynamics. Advanced degree and industrial experience required. Salary and academic rank commensurate with education and experience. In applying, enclose résumé of education and experience and state desired salary.

Available

793. Engineering Manager or Chief—B.S. M.E., Registered P.E. Twenty-two years in engineering, largely in aircraft and missiles, at responsible levels. Creative; sales conscious. Highly skilled in organizing and directing difficult engineering operations in weapons systems development and in the structural-electronic-mechanical and experimental engineering fields. Adept in managing, in using advanced techniques in organization, and in personnel development and relations for maximum sustained output. Desires position of high challenge. Salary area, $15,000. Résumé

792. Sales Engineer—Age 41. Eighteen years in sales, 8 years in technical sales to aircraft industry. Specialized in the introduction and promotion of new developments in the aircraft fastener field. Successful record and excellent reputation with all aircraft and missile plants in the western states. Currently employed as sales manager for a western fastener manufacturer. Interested in affiliation with a firm looking for sound sales management and development of excellent customer relationships. Located in southern California; will travel. Résumé on request.

791. Mechanical Engineer—B.S. in M.E. with M.S. equivalent in E.E. from U.S. Air Force Institute of Technology (automatic controls and armament) and a basic knowledge of aerodynamics (stability and control). Three years' Air Force experience in project engineering

management, 1½ years of which were spent as sole Air Force representative at contractor-operated facility. Prefers location west of the Mississippi. Please send position description with reply.

790. Aeronautical Engineer—Six and one half years' experience, last 2 years in air-frame development unit of missile research program involving satellite and re-entry developments, also IRBM application; Deputy Unit Chief. B.S. in Ae.E. and some graduate work. Desires responsible job in missile air-frame or related field and opportunity to continue education.

786. Aeronautical-Mechanical Engineering Supervisor—Ten years' experience in aeronautical research, design, and supervision. Desires position in nondefense industry. Preferred location, northern California.

785. Senior Government Engineer—Eligible for retirement in 1957, is available for employment on post by civilian contractor. Five years at White Sands in executive capacity; civilian background—chief research engineer, aircraft accessories. Licensed pilot, licensed professional engineer.

784. Administrative Engineer or Executive Assistant—Fifteen years' experience in aircraft and jet-engine industry. Three years as Assistant to General Manager of medium-size aircraft manufacturer. Extensive experience in program administration and Government contracts administration. Good background in design and production engineering. Broad experience in coordinating complex management programs with above-average ability to get along with sales, accounting, engineering, and production executives. Desires position which will provide opportunities for advancing experience in business administration. Prefers location in northeastern Ohio, western Pennsylvania, or western New York. Age 32. Résumé and salary requirements on request.

MECHANICAL ENGINEERS

Military electronics projects of increasing magnitude and complexity have created exceptional career potentials for mechanical and electromechanical engineers at Hoffman. If you are keenly interested in enhancing your professional stature, and prefer to work for a growth leader in the electronic field, you are invited to write Vice President of Engineering:

Hoffman LABORATORIES, INC.
A SUBSIDIARY OF HOFFMAN ELECTRONICS CORP.
3761 South Hill St., Los Angeles 7, Calif.
Telephone: RIchmond 9-4831.

CHALLENGING OPPORTUNITIES IN RESEARCH AND DEVELOPMENT for

FLUID MECHANICS ENGINEERS
Engineers of advanced standing will find challenging work at the Garfield Thomas Water Tunnel of the Ordnance Research Laboratory located at The Pennsylvania State University. This laboratory is engaged in basic and applied research in the field of underwater propulsion and related subjects, including cavitation, hydroelasticity, and hydrodynamic control of submerged bodies. The existing openings offer opportunities for combining research and development work in these fields with various academic activities.

MECHANICAL ENGINEERS
Mechanical engineers with research ability and experience in missile development.

University Faculty Appointments
Opportunities for Graduate Study
Liberal Vacation Allowances
Security Benefit Programs

Send Resume to:
ARNOLD ADDISON, Personnel Director
THE PENNSYLVANIA STATE UNIVERSITY
ORDNANCE RESEARCH LABORATORY
University Park Pennsylvania

IF YOU ARE IN A DEAD-END SPOT IN AERO-ENGINEERING

AN AGGRESSIVE, EXPANDING MIDWEST AIRFRAME COMPANY HAS IMMEDIATE OPENINGS IN THE FOLLOWING CATEGORIES:

STRUCTURAL DESIGNERS • SENIOR STRESS ENGINEER
STRESS ANALYST or ENGINEER
AERODYNAMICIST—ASSOCIATE
AVIONICS—Associate or Senior
AERONAUTICAL ENGINEER—(Stability and Control)
MECHANICAL DESIGNERS
WEIGHTS ENGINEER • METALLURGISTS

FULL SALARIES—EXCELLENT PROFIT-SHARING PLAN
PLEASANT LOCATION

Send Replies to:
Box 798, Aeronautical Engineering Review

AERODYNAMICISTS

Graduate aeronautical engineers required for work in aerodynamic techniques of high precision. This job provides an excellent opportunity to perform specialized functions including design and application of analog computers to missile and aircraft performance, stability and control, autopilot and guidance problems.

Opportunities for advancement combined with excellent company benefits and pleasant surroundings in upstate N.Y. make this an unusual opening.

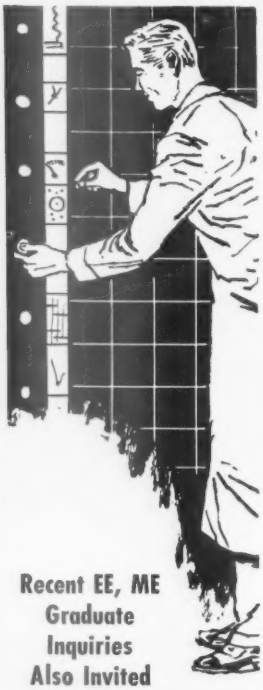
For further information please call Dr. Larry Fogarty collect, Binghampton 3-6311, ext. 386.

LINK AVIATION, INC.
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION
BINGHAMTON, NEW YORK
GPE

Servo Engineers

ELECTRICAL MECHANICAL

Inertial Guidance System Program



Enjoy Challenging Opportunities in the further development and systems testing of Inertial Guidance Systems and their Servo Loops in the most versatile laboratories in the country.

Work with the top men in the field and with the finest test, research and development facilities. New plant being added in suburban Milwaukee as a part of Major, Permanent, Expansion Program.

AC will provide financial assistance towards your Master's Degree. A Graduate Program is available evenings at the University of Wisconsin, Milwaukee.

GM's long-standing policy of decentralization creates individual opportunity and recognition for each Engineer hired.

Milwaukee offers ideal family living combining small town hospitality with every metropolitan shopping and cultural advantage.

For personal, confidential interview in your locality send complete resume to

Mr. Cecil E. Sundeen, Supervisor of Technical Employment

Recent EE, ME Graduate Inquiries Also Invited

AC

THE ELECTRONICS DIVISION

GENERAL MOTORS CORPORATION

FLINT 2, MICH. • MILWAUKEE 2, WIS.

RESEARCH ENGINEERS

The Armour Research Foundation has a limited number of top level research positions for individuals possessing a high degree of ingenuity and imagination. These positions provide excellent advancement opportunities into management or senior research positions, of equivalent rank, in the following general fields:

Aerophysics
Combustion
Heat Transfer
Thermodynamics
Compressible and Incompressible Flow
Weapons Systems Analysis

Only individuals capable of applying their proven research abilities within the above fields will be considered. Excellent educational and other employee benefits. Salary open. Please send resume to:

Mr. J. A. Metzger

ARMOUR RESEARCH FOUNDATION
of
Illinois Institute of Technology
10 West 35th Street
Chicago, Illinois

Air Transport Operations Engineer

Lockheed's expanding operational assistance services to more than 20 airlines throughout the world has created a new position for an engineer possessing current experience in air transport operation and performance analysis.

The position involves extensive liaison with airlines and the solution of operating problems on current and projected types of transport aircraft. You will be based at Lockheed's Airline Operations Engineering Department in Burbank.

Please address inquiries to E. W. Des Lauriers, Dept. 0503A.

LOCKHEED
Aircraft Corporation
CALIFORNIA Division
BURBANK, CALIFORNIA

Aeronautical Engineers

Did You Know
THAT YOUR PRESENT SKILLS FIT YOU FOR IMPORTANT ASSIGNMENTS *in*
AIRCRAFT NUCLEAR PROPULSION

Whether or not you have previous nuclear experience, the skill you now have can be applied to the development of nuclear power systems for aircraft—with rewards for you that are possible only in a field as important as this.

We will train you in the nuclear applications of your field through:

- A full-tuition refund plan for university courses leading to an M.S. degree in nuclear engineering or any graduate degree.
- In-plant training courses providing the most complete nucleonics knowledge available today.
- On the job training with top specialists.

Now is the time for alert, ambitious engineers to change over to one of the most important fields of the atomic era because . . .

Aircraft Nuclear Propulsion at our company has reached the product stage

This means that earlier research has paid off, and a big upsurge in new development can be expected.

Immediate openings in applications of:
Stress and weight analysis, turbo-jet, thermodynamics, shield design, remote handling, heat transfer, cycle analysis, power plant components, reactor design and structures, fluid heat-flow transfer.

Openings are with a major industrial firm. 2 locations: West and Midwest.

Send resume in confidence, stating salary requirements, to:

Box 796
Aeronautical Engineering Review

Index to Advertisers

AC Electronics Div., General Motors Corp. 85, 178
*Adel Div., General Metals Corp. 82
Aeronautical Engineering Catalog 139
Aeronautical Engineering Review 139, 149
Airborne Accessories Corp. 15
AiResearch Mfg. Divs., The Garrett Corp. 74, 75
American Latex Products Corp. 99
*Amphenol Electronics Corp. 70
Armour Research Foundation, Illinois Institute of Technology 178
Autonetics Div., North American Aviation, Inc. 157

*B & H Instrument Co., Inc. 93
Bendix Aviation Corp.
*Bendix Products Div. 135
Scintilla Div. 117
Boeing Airplane Co. 68
Boston Insulated Wire & Cable Co. 139

California Institute of Technology
Jet Propulsion Laboratory 180
Southern Calif. Cooperative Wind Tunnel 132
*Chain Belt Co., Shafer Bearing Div. 119
Chance Vought Aircraft Inc. 80, 81
Colonial Rubber Co. 92
Columbus Div., North American Aviation, Inc. 166
CONVAIR, A Div. of General Dynamics Corp. ..... Back Cover, 5, 149
Cornell Aeronautical Laboratory, Inc. 138

*Delavan Mfg. Co. 90
*Douglas Aircraft Co., Inc. 12, 13, 153
Dow Chemical Co., The 151

*Eastern Industries, Inc. ..... Inside Front Cover
*Electrical Engineering & Mfg. Corp. 129

Fairchild Engine and Airplane Corp.
Engine Div. 94
*Stratos Div. 16
*Fenwal Inc., Aviation Products Div. 63
Fluid Regulators Corp. 159
Foote Bros. Gear and Machine Corp. 143

Garrett Corp., The, AiResearch Mfg. Divs. 74, 75
General Dynamics Corp., CONVAIR Div. ..... Back Cover, 5, 149
*General Electric Co. 131, 144
*General Metals Corp., Adel Div. 82
General Mills, Inc., Mechanical Div. 65
General Motors Corp.
AC Electronics Div. 85, 178
Harrison Radiator Div. 79
New Departure Div. 127
*G.M. Giannini & Co., Inc. 73
B. F. Goodrich Co., The, Aviation Products Div. 61
Goodyear Tire & Rubber Co., Inc., The, Aviation Products Div. 1
Grumann Aircraft Engineering Corp. 165

Harrison Radiator Div., General Motors Corp. 79
Hoffman Laboratories, Inc. 177

Indiana Gear Works, Inc. 67

*Jack & Heintz, Inc. 145
Johns Hopkins University, The, Applied Physics Laboratory 148
Jones & Laughlin Steel Corp. 11

Kaman Aircraft Corp., The 96, 97
*Kearfott Co., Inc. 86
Walter Kidde & Co., Inc. 9

Lamb Electric Co., The 76
*Lear, Inc., Lear-Romec Div. 100
Link Aviation, Inc. 177
Lockheed Aircraft Corp.
California Div. 140, 141, 155, 178

*Manning, Maxwell & Moore, Inc. 10
*Marquardt Aircraft Co. 156
Menasco Mfg. Co. 91
Minneapolis Honeywell Regulator Co., Aeronautical Div. 126
Moog Valve Co., Inc. 8

National Standard Co. 14
New Departure Div., General Motors Corp. 127
North American Aviation, Inc.
Autonetics Div. 157
Columbus Div. 166
Northrop Aircraft, Inc. 89

Pastushin Industries, Inc. 72
Pennsylvania State University, The, Ordnance Research Laboratory 177
Pittsburgh-Des Moines Steel Co. 6, 7
Pratt & Whitney Aircraft Div., United Aircraft Corp. 163

Radio Corp. of America 160
Ramo-Wooldridge Corp., The 174
Reaction Motors, Inc. 120
Republic Aviation Corp. 176
Robertshaw-Fulton Controls Co., Aeronautical Div. 121
*Rohr Aircraft Corp. 125
Ronald Press Co., The 169

Sargent Engineering Corp. 87
Scintilla Div., Bendix Aviation Corp. 117
*Shafer Bearing Div., Chain Belt Co. 119
*Solar Aircraft Co. 147, 171
Southern California Cooperative Wind Tunnel 132
*Sperry Rand Corp., Vickers, Inc. Div. 133
*Standard Pressed Steel Co., Aircraft Products Div. 4
Stanpat Co. 169
*Stratos Div., Fairchild Engine and Airplane Corp. 16
P. A. Sturtevant Co. 170
Surface Combustion Corp., Aircraft-Automotive Div. ..... Inside Back Cover
*Swedlow Plastics Co. 137

Temco Aircraft Corp. 173

United Aircraft Corp., Pratt & Whitney Aircraft Div. 163

*Vickers Inc. Div., Sperry Rand Corp. 133

Waldes Kohinoor, Inc. 123
Weltronic Co. 77
*Weston Electrical Instrument Corp., A Subsidiary of Daystrom, Inc. 95
John Wiley & Sons, Inc. 168, 170
*Wittek Mfg. Co. 139

★ *Specifications and further information on the aircraft products of these companies will be found in the* 1957 AERONAUTICAL ENGINEERING CATALOG

The only publication of its kind devoted exclusively to the aircraft industry, this CATALOG serves as a valuable buyers' and reference guide to sources and specifications on aircraft materials, parts, and accessories. It is distributed annually to Chief Engineers, Designers, Production Heads, and Purchasing Departments of all leading Aircraft, Aircraft Engine, Instrument, Accessory, and Aircraft Parts Manufacturers; Air Transport Companies; Army, Navy, and Governmental Agencies; Research Organizations; Engineering Libraries; etc.

Published Annually by

INSTITUTE OF THE AERONAUTICAL SCIENCES

2 East 64th Street New York 21, N.Y.

IMPORTANT DEVELOPMENTS AT JPL

The Jet Propulsion Laboratory is a stable reseach and development center located north of Pasadena in the foothills of the San Gabriel mountains. Covering an 80 acre area and employing 1700 people, it is close to attractive residential areas.

The Laboratory is staffed by the California Institute of Technology and develops its many projects in basic research under contract with the U.S. Government.

Opportunities open to qualified engineers of U.S. citizenship. Inquiries now invited.

Tactics for Defense

The complexity of modern weapon systems, the variety in new development possibilities, the shortage of trained personnel and the limited time factor make it imperative for the United States Army to evaluate its present and future tactical capabilities. To that end, a new operations research group is being organized at JPL to explore present and future possibilities and to contribute to the understanding and solution of apparent problems.

Studies will be made regarding the offensive and defensive weapons now at our disposal as well as those being developed and proposed. Tactics for their current and probable use and disposition will be studied and evaluated. Information regarding known and probable opponent weapons and tactics must also be gathered and co-ordinated and a reasonable estimate made as to their possible employment. Plans and procedures for countering and offsetting such opponent activities are of immediate importance.

For the staff of this special group, the Jet Propulsion Laboratory seeks open-minded and imaginative engineers and scientists of every classification. If you are interested in and have a strong desire to become a part of such a program, you are invited to submit your resume for immediate consideration.

JOB OPPORTUNITIES IN THESE FIELDS NOW

jpl

AERONAUTICS • MECHANICAL • STRUCTURES • DYNAMICS • PROPULSION
APPLIED MECHANICS • INERTIAL ELEMENTS • METALLURGY • CERAMICS
SOLID STATE PHYSICS • OPERATIONS RESEARCH

JET PROPULSION LABORATORY

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA • CALIFORNIA

M/

New Products and Product Literature of interest to IAS members

▼▼▼▼

AIRCRAFT MATERIALS & PROCESSES

"Stainless Castings." 28-page booklet gives data on corrosion-and-heat resistant castings. **Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22.**

"Powdiron FM" Pure Sintered Iron Material. Features superior machineability; particularly adaptable as a bearing material. **Bound Brook Oil-Less Bearing Co., Bound Brook, N.J.**

"Cohrlastic" Silicone Rubber Coated & Nylon Resin Coated Fabrics. 4-page bulletin gives complete data. **The Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.**

Low Durometer Silicon Rubber Stock. "Cohrlastic" R-11568 has compressibility in the range of silicone sponge rubber. **The Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.**

Ultra-Fine Particle Iron Magnet. This new superstrong magnet can result in electric instruments that are smaller, lighter, more accurate, and more rugged. **General Electric Co., Schenectady 5, N.Y.**

High-Temperature Lubricant No. 49. Has low carbon content and anti-gumming features. **Keystone Lubricating Co., 3100 N. 21 St., Philadelphia.**

High Heat Transparent Rubber. Used as an interlayer in aircraft windshields; permits the glass to withstand twice as much heat from air friction at high speeds. **Libbey-Owens-Ford Glass Co., 608 Madison Ave., Toledo 3, Ohio.**

Powered Metal Parts. 12-page booklet gives detailed information on the process and manufacturing techniques. **The Lux Clock Mfg. Co., 100 Johnson St., Waterbury, Conn.**

Pressure Sensitive Tapes. Mystik brand #7000-G for 100° to 550°F. operations; has fiberglass backing; adhesive one side. **Mystik Adhesive Products, Inc., 2635 N. Kildare Ave., Chicago 39.**

Experimental Stainless Springs. In both open and closed wound types for development and research work. **PIC Design Corp., 477 Atlantic Ave., E. Rockaway, N.Y.**

Chemical Titanium Descaling Process. Descales titanium and its alloys without adversely affecting physical and chemical properties. **Turco Products, Inc., 6135 S. Central Ave., Los Angeles 1.**

1957 Listing of Union Carbide Products. This 12-page booklet lists all company products by type and trade name. **Union Carbide & Carbon Corp., 30 E. 42 St., New York 17.**

Thin-Wall Welded Tubing in Continuous Lengths. New process forms and welds in continuous lengths to 200 ft. **Universal Tube Corp., 2133 S. Kedzie Ave., Chicago 23.**

Aluminum-Clad Copper Wire. This new metallurgical technique can allow electrical equipment to operate longer at higher temperatures than are now practical. **Westinghouse Electric Corp., Box 2278, Pittsburgh 30.**

Deep Drawn Titanium Alloys. This new process permits fabrication of titanium alloys by mass-production stamping methods. **Worcester Pressed Steel Co., Worcester, Mass.**

AIRCRAFT PARTS & EQUIPMENT

210-hp. Helicopter Engine. This new engine maintains 200 hp. at 1,500 ft. altitude or at 110°F. **Aircooled Motors, Inc., Syracuse, N.Y.**

TM-4 Water Squeezer Expeditionary Arresting Gear. Stops jets on short airfields. **All American Engrg. Co., Box USS 2668, DuPont Airport, Wilmington 5, Del.**

USE THESE TEAR-OUT POSTALS TO REQUEST ADDITIONAL INFORMATION DIRECT FROM THE MANUFACTURERS LISTED IN THIS SECTION AND FROM ADVERTISERS IN THIS ISSUE ☞

Aeronautical Engineering Review

REQUEST FOR PRODUCT INFORMATION

An Official Publication INSTITUTE OF THE AERONAUTICAL SCIENCES (Aviation's Professional Engineering Society)

2 E. 64th St., New York 21, N.Y.

Please send information on the following item mentioned in the _____ Issue of AERONAUTICAL ENGINEERING REVIEW

NAME ..... POSITION .....

COMPANY .....

STREET .....

CITY & STATE .....

Aeronautical Engineering Review

REQUEST FOR PRODUCT INFORMATION

An Official Publication INSTITUTE OF THE AERONAUTICAL SCIENCES (Aviation's Professional Engineering Society)

2 E. 64th St., New York 21, N.Y.

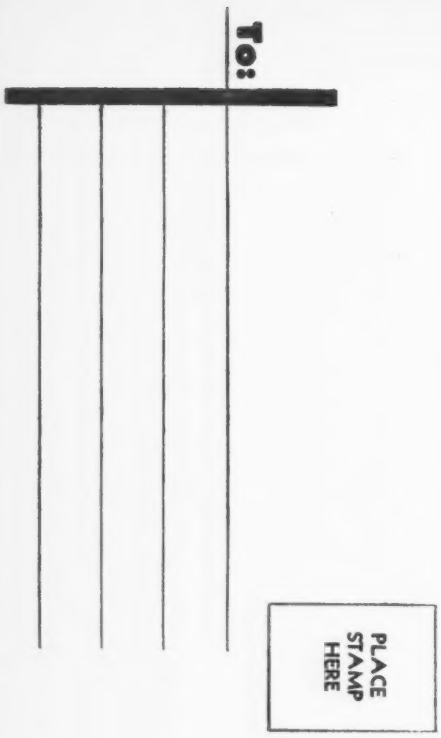
Please send information on the following item mentioned in the _____ Issue of AERONAUTICAL ENGINEERING REVIEW

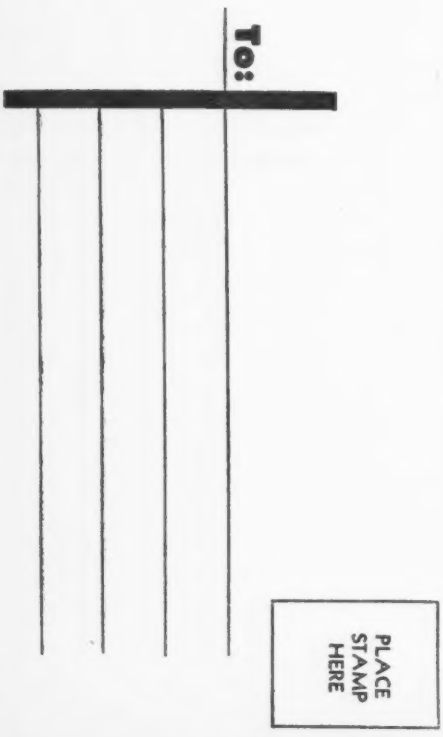
NAME ..... POSITION .....

COMPANY .....

STREET .....

CITY & STATE .....





Type PYLC Rotary Actuator. This electromechanical unit moves a 7.5 lb. in. load 95 deg. in 0.2 sec.; performs in temperatures ranging from −65° to +200°F. **Barber-Colman Co., 1426 Rock St., Rockford, Ill.**

Failsafe Remote Positioning System. Will operate under any statistically reasonable failure or will remain in position; for power-plant control, secondary flight control surfaces, etc. **The Bristol Co., Waterbury 20, Conn.**

Pressure Transducer. For both air-borne and ground applications; designed for service with jet and piston-engine fuels, lubricating and hydraulic oils, air, carbon dioxide, and oxygen. **The Bristol Co., Waterbury 20, Conn.**

"Cobra-Lox" Liquid Oxygen Transfer Hose. The inner hose is corrugated from all brass seamless tubing; insulation in turn is covered by a stronger and more wear-resistant material. **Cobra Metal Hose, 4640 W. 54 St., Chicago.**

Servomotor Tachometer Generator. Features a ±0.5 per cent linearity. **Eastern Air Devices, Inc., 377 Central Ave., Dover, N.H.**

Model 345 Air-Borne Loran Receiver. This is the first civilian Loran designed solely for air-borne applications; features a cockpit installation and display under pilot control; weighs approximately 26 lbs. **Edo Corp., College Point, N.Y.**

"Flying Turnbuckle" Helicopter Blade Trim Actuator. With this unit the helicopter pilot can trim pitch of blades in 4 sec.; formerly required nearly an hour by a ground crew. **The Garrett Corp., AiResearch Mfg. Co. Div., 9851 Sepulveda Blvd., Los Angeles 45.**

Two-Position Hydraulic Selector Valve. This solenoid-operated three-way unit features very high speed of operation. **Gladden Products Corp., 635 W. Colorado, Glendale 4, Calif.**

Cold Weather Tubeless Aircraft Tires. Withstands temperatures of −65°F. and lower. **Goodyear Tire & Rubber Co., Akron 16, Ohio.**

Miniature Differentials. Feature minimum backlash, high accuracy, and low breakaway torque. **Helipot Corp., Newport Beach, Calif.**

Series RG03-0100 Rate Gyro. Designed especially for missile applications having severe shock and vibration requirements. **Humphrey, Inc., 2805 Canon St., San Diego 6, Calif.**

3-Oz. Accelerometer. Series LA03-0200 features an operating temperature ranging from −50° to +100°C.; withstands vibration from 0 to 2,000 cps to 10*g*; shock-resistant to 40*g*. **Humphrey, Inc., 2805 Cannon St., San Diego 6, Calif.**

"Circle Seal" Shuttle Valves. Feature very low shuttling pressure, dead tight sealing at low-pressure differentials, and long maintenance-free service life. **James-Pond-Clark, 2181 E. Green St., Pasadena, Calif.**

Fire & Overheat Detector for Aircraft. 8-page brochure describes operation. **Walter Kidde & Co., Inc., Aviation Div., Belleville, N.J.**

Speed Governor & Tachometer Switch. The unit is essentially a one-speed governor which has been preset to cut in at a particular speed. **The Lee Co., Wesley Ave., Westbrook, Conn.**

"FE 200" Position Distance Indicator. Features uniform illumination of all pointer and dial markings. **Marion Electrical Instrument Co., Grenier Field, Manchester, N.H.**

Miniature Electrical Indicating Instrument. Displays two functions in a case measuring $1^9/_{32}$ in. in dia. by 2 in. in length. **Marion Electrical Instrument Co., Grenier Field, Manchester, N.H.**

Klixon M1 Thermostat. This snap-acting type of unit is hermetically sealed and vibration resistant; weight is 4 gm. **Metals & Controls Corp., Spencer Thermostat Div., Attleboro, Mass.**

Electromechanical Release & Ejection Mechanisms. 4-page brochure describes company's line of products. **Microloc Corp., 5300 W. 104 St., Los Angeles 45.**

"Scru-Tite" Tubular Fitting. Features serrations on both nut and hub for increased metal-to-metal surface grip. **Myers Electric Products, Inc., 3019 S. Vail Ave., Montebello, Calif.**

Multi-Breakout Electronic Harness Assembly. Designed as an interconnector between ground test equipment and air-borne equipment for preflight check-out. **Pacific Automation Products, Inc., 1000 Air Way, Glendale 1, Calif.**

Model HP31 High-Pressure Air-Line Lubricator. This device introduces a controlled oil fog into an air stream at normal working pressures up to 2,000 psi. **The Rucker Co., Oakland, Calif.**

Lightweight Miniature Oxygen Pressure Regulator. For high-density transport aircraft, Model #10270 can supply the entire requirements for a crew demand oxygen system. **Scott Aviation Corp., 302 Eire St., Lancaster, N.Y.**

Miniature Motor-Gearhead-Clutch. 0.938 in. in dia.; maximum length $1^3/_4$ in.; designed to operate directly from either a 115- or a 26-volt line. **Servomechanisms, Inc., 625 Main St., Westbury, N.Y.**

Model 195 Four-Way Oxygen Manifold. For pilot protection in high-speed high-altitude bail outs; a decompression valve relieves all internal pressure in the manifold, hose, and mask. **Sierra Engineering Co., 123 E. Montecito, Sierra Madre, Calif.**

"Packaged Power" Pull-Type Actuator. This cartridge actuated unit is attached directly to the object to be pulled; for emergency condition applications in high-performance aircraft. **The Talco Engineering Co., Hamden, Conn.**

Monel Hollow Pull-Thru Rivet. This rivet has been developed for fastening miniature nut plates and gang channels. **Cherry Rivet Div., Townsend Co., Box 2157-Z, Santa Ana, Calif.**

Oil Seal Engineering Catalog. Edition No. 305 covers shaft sealing equipment. **Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90.**

Aircraft Valves, Fittings, Cylinders, Forgings, & Assemblies. 72-page catalog AC-301 contains descriptive material on the complete Weatherhead line. **The Weatherhead Co., 300 E. 131 St., Cleveland.**

Cockpit Landing Gear Control. Prevents inadvertent raising of the landing gear when in the "down" position. **Wemac, Inc., 502 S. Iris, Inglewood, Calif.**

ELECTRONIC & ELECTRICAL EQUIPMENT

"Acepot" Subminiature Potentiometers. Now available with linearity of ±0.1 per cent. **Ace Electronics Associates, Inc., 103 Dover St., Somerville 44, Mass.**

Miniaturized Radio Frequency Filters and Starting Capacitors. These small units are more efficient; a 2½-oz. capacitor, for example, has twice the capacity of a conventional 10-oz. capacitor at triple the voltage. **Airborne Accessories Corp., Hillside, N.J.**

"Top-Tainers" Top-Holding Electronic Tube & Component Retainers. Holds all tubes and cylindrical components ranging from 7/8 to 2⅛ in. in dia. **The Birtcher Corp., 4371 Valley Blvd., Los Angeles 32.**

Sensing Relay for Aircraft Component Applications. This device uses snap-action switches. **Cook Electric Co., 2700 Southport Ave., Chicago 14.**

Moulded Printed Circuit Panel. Eliminates the use of expensive piercing dies and punch presses. **Die Form Circuits, Inc., 6045 W. Ogden Ave., Cicero, Ill.**

High-Temperature, Infinite-Resolution Potentiometer. Model 85177A uses special materials and alloys in the winding and vital elements to allow a power rating of 1.5 watts at 150°C. **G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.**

Critical Temperature Electronic Cable. Features stable performance characteristics under environmental temperatures ranging from −85° to +410°F. **Hall-Scott, Inc., 2850 Seventh St., Berkeley, Calif.**

Helipot Series B Potentiometers. Data sheet 54-18 describes improved operating characteristics. **Helipot Corp., Newport Beach, Calif.**

Sector Potentiometers. Designed to measure angles from zero to a maximum of 90° of shaft rotation. **Humphrey, Inc., 2805 Canon St., San Diego 6, Calif.**

MRP 22-.1 Air-Borne Power Supply. This line transient-free, short circuit-proof unit provides 22.5 volts d.c. for telemetering and instrumentation applications. **Magnetic Research Corp., 202 Center St., El Segundo, Calif.**

Type 4-C Relay. For applications permitting minimum size but requiring maximum sensitivity, long life, and low power consumption. **Phillips Control Corp., Joliet, Ill.**

High-Temperature Aircraft Hook-Up Wires. Bulletin No. 1906 describes this series of single-conductor, 600-volt wires. **Revere Corp. of America, Wallingford, Conn.**

Model SG-132 VHF-UHF Sweep Generator. Applications include testing and aligning VHF-UHF communication receivers, measuring sensitivity, selectivity, image rejection, and gain of receivers and other equipment. **Transitron, Inc., 186 Granite St., Manchester, N.H.**

Concentric-Shaft Potentiometers. This design permits two potentiometers to be single-hole mounted for control by a dual knob. **Waters Mfg., Inc., P.O. Box 368, S. Sudbury, Mass.**

Plug-In 1/2-In. Precision Potentiometer. Model APP-1/2 can be installed in miniaturized assemblies that use printed-circuit techniques. **Waters Mfg., Inc., P.O. Box 368, S. Sudbury, Mass.**

"Pot-Hook" Flush- or Recessed-Mounting Device for Controls. Provides no-tamper, sealed, panel installation. **Waters Mfg., Inc., P.O. Box 368, S. Sudbury, Mass.**

Transistorized D.C. Voltage Regulator. Offered in two models of varying current capacities; designed for rugged environmental conditions. **Western Gear Corp., Lynwood, Calif.**

Electronic Time Delay Relay. Requires no warm-up; consumes as little as 1 watt. **G. C. Wilson & Co., 1915 8th Ave., Huntington, W.Va.**

DRAFTING ROOM, PRODUCTION, & MISC. EQUIPMENT

Ultrasonic Soldering Iron. Solders aluminum without flux by completely removing all oxide film on the metal surface. **Acoustica Associates, Inc., Glenwood Landing, N.Y.**

USE THESE TEAR-OUT POSTALS TO REQUEST ADDITIONAL INFORMATION DIRECT FROM THE MANUFACTURERS LISTED IN THIS SECTION AND FROM ADVERTISERS IN THIS ISSUE ☞

Please send information on the following item mentioned in the _____ Issue of AERONAUTICAL ENGINEERING REVIEW

_____

_____

_____

NAME ..... POSITION .....

COMPANY .....

STREET .....

CITY & STATE .....

Aeronautical Engineering Review

REQUEST FOR PRODUCT INFORMATION

An Official Publication INSTITUTE OF THE AERONAUTICAL SCIENCES (Aviation's Professional Engineering Society)

2 E. 64th St., New York 21, N.Y.

Please send information on the following item mentioned in the _____ Issue of AERONAUTICAL ENGINEERING REVIEW

_____

_____

_____

NAME ..... POSITION .....

COMPANY .....

STREET .....

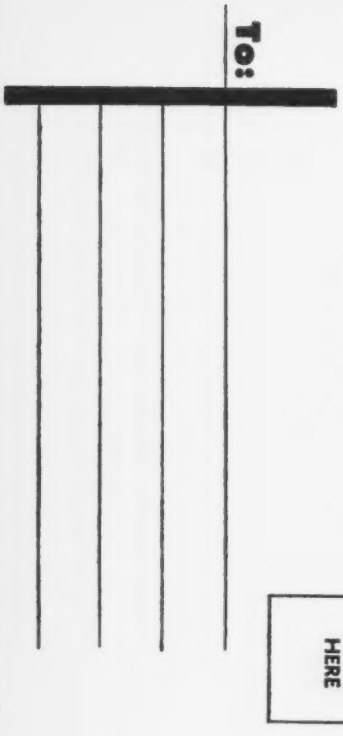
CITY & STATE .....

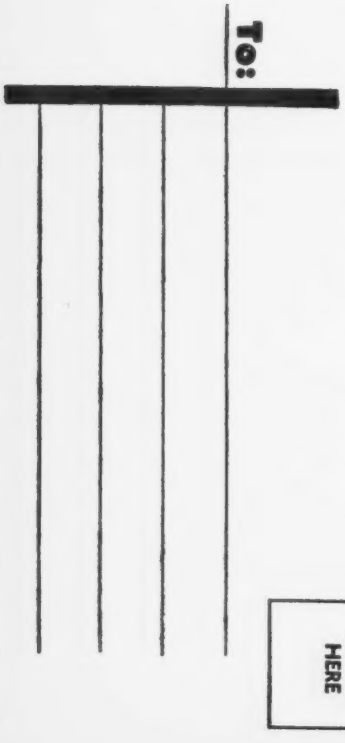
Aeronautical Engineering Review

REQUEST FOR PRODUCT INFORMATION

An Official Publication INSTITUTE OF THE AERONAUTICAL SCIENCES (Aviation's Professional Engineering Society)

2 E. 64th St., New York 21, N.Y.





Micro-Master Reproduction Process. Puts huge engineering drawings on negatives only 4 by 6 in. in size; can be enlarged back to the original size without distortion or loss of detail. **Keuffel & Esser Co., Hoboken, N.J.**

"Dust Control for Industry." 16-page bulletin describes complete range of dust control equipment and accessories. **Pangborn Corp., Hagerstown, Md.**

Portable Blueprint Machine. Weighs 5½ lbs. in carrying case; reproduces any type of drawing or written matter up to 8½ by 14 in. in less than 1½ min. **Product Engineering Laboratories Co., Inc., PELprinter Div., 314 Adams St., Newark 5, N.J.**

RESEARCH & TEST EQUIPMENT

Model KT-1 Portable Transistorized Instrument. For measurement of transistor parameters in quality control testing, circuit design, etc. **Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.**

"Ease" 1100 Series Analog Computer. Combines a digital output-input translator system; programed with punched tape. **Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif.**

Bendix G-15D General-Purpose Digital Computer. 6-page bulletin describes unit and its digital differential analyzer accessory. **Bendix Computer Div., Bendix Aviation Corp., 5630 Arbor Vitae St., Los Angeles 45.**

Semiautomatic Programed Test Set. With digital printed read-out; developed for use in final testing of missile telemetering packages. **Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, No. Hollywood, Calif.**

Subminiature Sequence Timer. Developed for balloon instrumentation; weighs 3½ to 4½ oz.; measures 2¼ in. high, 1¾ in. wide, and 1¾ to 2⅝ in. deep. **Brailsford & Co. Inc., 670 Milton Rd., Rye, N.Y.**

Model J Commercial Jet Aircraft Thrust Stand. Capable of accommodating the Douglas DC-8 and Boeing 707 air liners. **Bristol Engineering Corp., Bristol, Pa.**

Galvanometers. 12-page Bulletin 1528 gives complete data on these units. **Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.**

Low-Range Torque Transducers. Model TF-5-0.5 has full torque range of 0.5 in.lbs.; Model TF-5-0.05 has full torque range of 0.05 in.lbs. **Crescent Engineering & Research Co., 5440 No. Peck Rd., El Monte, Calif.**

Model 8915 "Rotostepper" Electromechanical Shaft Positioning Device. This pulse to analog converter provides controlled incremental shaft rotation of one 2° step per d.c. pulse. **G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.**

"Recti/Riter" Rectinlinear Writing Galvanometric Recorder. 6-page Bulletin R-501 details design, construction, and operator convenience features. **Houston Technical Laboratories, 3609 Buffalo Speedway, Houston 6, Tex.**

Electron Microscopes. 12-page brochure gives complete data on construction and operation. **North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N.Y.**

Electronic Test Equipment & Components. 24-page catalog; covers all types of test apparatus. **Northeastern Engineering, Inc., Manchester, N.H.**

"Dynograph" High-Speed Direct Writing Oscillograph. 12-page catalog describes unit for recording a variety of dynamic and static variables. **Offner Electronics, Inc., 5320 N. Kedzie Ave., Chicago 25.**

Sonic Analyzer LP-1a. Identifies mechanical and electrical defects and variations. **Panoramic Radio Products, Inc., 10 S. 2 Ave., Mt. Vernon, N.Y.**

8-Cu.Ft. Low-Temperature Cabinet. Designed for testing electronic components, stabilization of metals, and thermal contraction and expansion fitting. **Webber Engineering Corp., P.O. Box 217, Dept. 361, Indianapolis 6.**

Turntable for Field Testing Air-Borne Gyroscopes. For use aboard aircraft carriers; the table is gyroscopically controlled so that it is held independent of ship action. **Westinghouse Electric Corp., Box 2278, Pittsburgh 30.**

NEW LITERATURE OFFERED BY ADVERTISERS

Rigid & Flexible Stafoam. American Latex Products Corp., 3341 W. El Segundo Blvd., Hawthorne, Calif. *See page 99*

Custom Compounding & Molding of Rubber & Silicone Rubber. Brochure. **Colonial Rubber Co., Ravenna, Ohio.** *See page 92*

Hydraulics, Pumps, Motors & Valves. Bulletin No. 7504. **Vickers, Inc., 1414 Oakman Blvd., Detroit.** *See page 133*

Janitrol
Dubl-Lock* couplings double safe

Janitrol's newest line of light-weight Dubl-Lock* couplings (clamp and flanges) provide extra safety for extremely critical bleed-air duct connections on jet aircraft. If bolt unlatches or fails, Dubl-Lock* couplings maintain the seal . . . positively prevent coupling failure! How it protects: when lock nut is tightened, barbed tang automatically moves into position and locks the clamp tight, even if bolt fails completely. To release, unscrew lock nut—apply thumb pressure.

Both Janitrol's Dubl-Lock* and Standard lines of couplings save up to 40% in weight, couple and uncouple with ease as often as necessary, require no compounds or sealing devices because flange seal is metal-to-metal. They withstand high temperatures, high pressures, surges, vibration, misalignment, and corrosion. Dubl-Lock* line: 13 sizes available —2″ to 6″. Standard line: 15 sizes—1½″ to 6″.

Call your nearest Janitrol representative or write direct.

Janitrol Aircraft-Automotive Division, Surface Combustion Corporation, Columbus 16, Ohio . . . District Engineering Offices: Washington, D. C., Philadelphia, Columbus, Fort Worth, Hollywood.

**Trademark of Surface Combustion Corporation*

COMBUSTION SYSTEMS, HEAT EXCHANGERS, PNEUMATIC CONTROLS

Janitrol®

A NEW FORCE FOR FREEDOM SPREADS ITS SUPERSONIC WINGS

Convair's B-58...America's first SUPERSONIC Bomber!

Leading the way today with the delta shape of tomorrow! Convair's B-58 supersonic bomber brings new dimensions of protection to help preserve a world of continuing peace. **CONVAIR-FORT WORTH** developed and perfected the delta wing into America's *first* supersonic bomber – proof again of Convair's leadership through **Engineering to the Nth power!** Like the already famous delta-wing F-102A Interceptor, also developed by Convair, the B-58 offers the U.S. Air Force an added new supersonic *force for freedom!*

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION